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NORTH AMERICA IN THE ICE PERIOD.

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ALTHOUGH the glaciated area on our continent has been as yet but partially explored, abundant proof has been gained, as it seems to me, of the truth of the following propositions, viz.:

1. That glaciers once covered most of the elevated portions of the mountain-belts in the West as far south as the thirty-sixth parallel, and all the eastern half of the continent to the fortieth parallel of latitude.

2. That the ancient glaciers which occupied the area described were not produced by local causes, but were the exponents of a general climatic condition.

3. That they could not have been the effect of a warm climate and an abundant precipitation of moisture, but were the results of a general depression of temperature, and therefore afford proof of the truth of what is called the glacial theory.

The facts and arguments which sustain these propositions may be briefly summarized as follows:

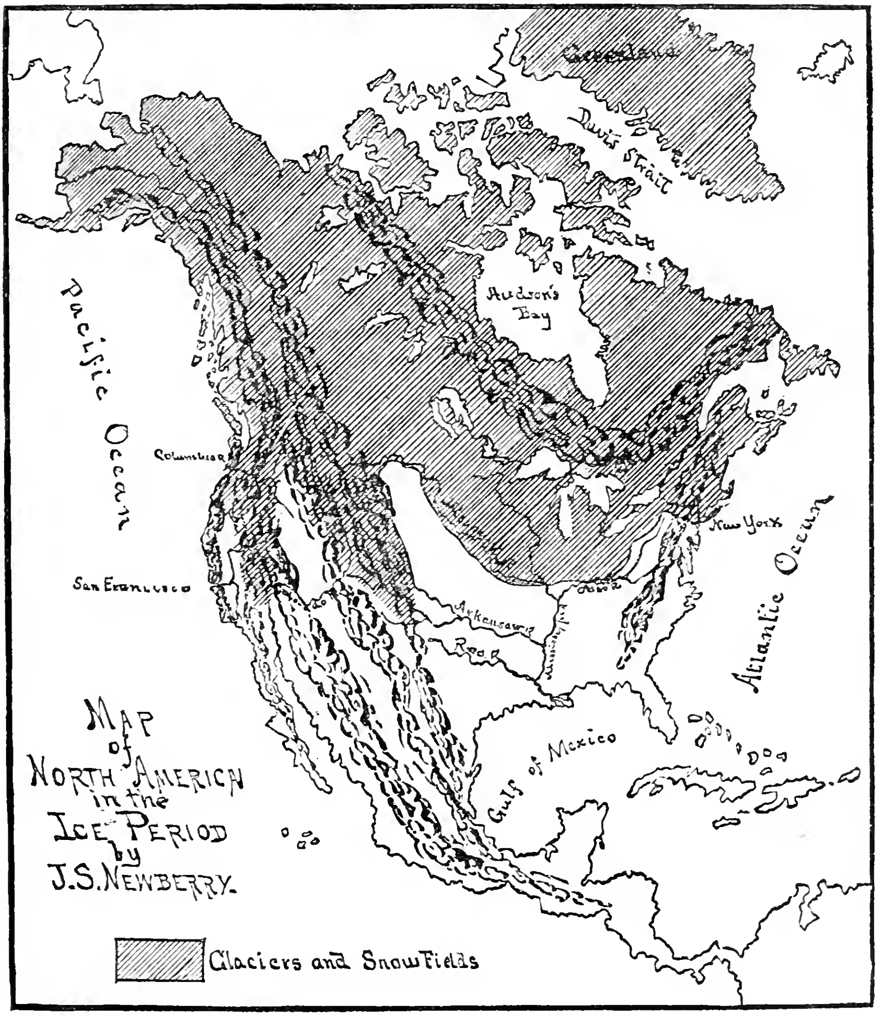
The glaciation of the Sierra Nevada is general and very striking. It has been studied by Whitney, King, Brewer, Le Conte, and others, including the writer, who have given abundant proof that all the highest portions of the range were once covered with snow-fields, and that glaciers flowed from these down the valleys on either side. Mount Shasta once bore many great glaciers, of which miniature representatives still remain; the Cascade Mountains exhibit, perhaps, the most impressive record of ice-action known; all the higher portions of the range are planed and furrowed by glaciers which descended into the valley of the Des Chutes on the east, and the Willamette on the west, as shown by my observations in 1855, at least twenty-five hundred feet below the present snow-line. Mount Rainier still carries a dozen glaciers of considerable size, and all the country is glaciated about this and the other snow-peaks of Washington Territory, Mount St. Helen's, Mount Baker, Mount Adams, Mount Olympus, etc., around Puget's Sound, and on Vancouver's Island. In British Columbia, as shown by George M. Dawson, Dr. Hector, James Richardson, and others, the signs of ancient glaciation are conspicuous in all the high country explored. Along the coast farther north the ancient glaciers have left their marks in all the fiords, and those of the present day descend lower and lower until in Alaska they reach the sea-level.

The valleys of the Wahsatch range were once filled with masses of ice as far south as Central Utah. A type of these, though not the largest, was Little Cottonwood glacier, of which the record has been carefully studied by the writer. It formed in a *cirque* at Alta ten to eleven thousand feet above the sea, where its bed is everywhere conspicuously glaciated. It had a length of about ten miles ; its thickness, as shown by the line of granitic blocks, left along its sides, was five hundred feet or more, and its lower end protruded into the Salt Lake Valley at a level not greater than fifty-five hundred feet above the ocean. The glaciation of the Uintah Mountains has been graphically described by King, who says that all the higher portions of the range were once covered with a continuous sheet of snow and ice, and that glaciers descended through all the important valleys ; also that the ancient glaciers of the Uintahs occupied a greater area than all those now existing in the Alps.

In the Rocky Mountain belt the signs of ancient glaciers abound from the northern part of New Mexico through Colorado and along the great divide in Wyoming, Montana, and Idaho. In the valley of the Arkansas, particularly about Leadville, in the Parks, on Clear Creek, in the valley of the Rio Grande, *roches moutonnées,* lateral and terminal moraines, embankment-lakes, etc., all the work of glaciers, have been observed by thousands of travelers. Here the mountain-belt is very broad and high, is now the great condenser from which radiate all the most important streams of the West, and in winter is covered with a heavy sheet of snow. In ancient times it played a similar *rôle,* only that the snows of winter did not melt as now in summer, but accumulated from year to year until they produced great glaciers. In Wyoming the mountains are narrower and lower, and the glacial signs are less conspicuous ; but toward the British line, where the ranges multiply and the summits are higher, the records of glaciation are everywhere apparent.

To summarize the description of the glacial phenomena of this Western region, it may be said that, over all the mountain-ranges north of the limit before given, the traces of ancient glaciation are alike in character and apparently of the same date, and are evidently the effects of general and not local causes.

In the country east of the Mississippi the evidence of ancient glaciation is even more wide-spread and impressive than in the far West. The surface-rocks of Canada, New England, New York, and the greater part of Ohio, Indiana, Illinois, and Wisconsin, bear marks of ice-action, and are generally covered with a sheet of drift material which has been carried from the north southward, often many hundred miles. This



glaciated and drift-covered area extends from Maine and Massachusetts in a belt parallel with the arch of the Canadian highlands five hundred miles wide and more than two thousand miles long. Its extension northward from the head-waters of the Mississippi has not been traced farther than Lake Winnipeg, where it was studied by

Hind; but there are good reasons for believing that it reaches northward to the Arctic Ocean, and that the great lakes of the north, like those of the St. Lawrence chain, Superior, Huron, Michigan, etc., are pre-glacial river-valleys scooped out and modified by ice.*

From the facts already gathered, it is a justifiable inference that fully half the Continent of North America and nearly all north of the fortieth parallel was at one time covered with ice or perpetual snow, and, so far as we can now judge, the glaciation of all the North American localities enumerated was synchronous.

Some writers have attempted to prove that a large part of the glacial phenomena described above is really the work of icebergs and shore-ice, and one of the consequences of a great continental subsidence; but no man who has studied the inscriptions made by glaciers will hold to this theory when he has traversed much of the glaciated areas east or west of the Mississippi. To all the mountainous region of the West it is evident that the iceberg theory is inapplicable, and, when the enormous glaciers of the West are conceded, it is difficult to see why they should be denied to the East. Since, however, the iceberg theory is insisted upon for this section, it may be well enough to say that it is demonstrated untrue by four unanswerable arguments:

1. The inequalities of level in the fancied water-line formed by the margin of the drift area are irreconcilable. Mount Washington, Mount Marcy, Mount Mansfield, must have been totally submerged—because their tops are worn and striated—while the shore-line was at New York at the sea-level, in Pennsylvania twenty-one hundred feet, and at Cincinnati three hundred feet higher. South of the drift-line, high lands and low were alike beyond the reach of the flood, while in Wisconsin it spared a special district not above the general level, and all around it the rocks are scored and strewed with *débris*.

2. The direction of the ice-scratches and the derivation of the bowlders would require the submergence of all the northern portion of the continent, so that icebergs (*which had no land to start from, and therefore could not have existed*) could float southward over all the Canadian highlands; and the local variations of direction (southwest by south, in the basin of Lake Erie, south in that of Lake Huron, south-southwest in Lake Michigan, southwest in Lake Superior, and southeast in New England) show an incomprehensible tangle of ocean-currents.

3. The complete absence of marine shells from the great drift area of the interior, while they are abundant in the Champlain and bowlder clays on the coast, is incompatible with this theory.

4. The inscription left by the eroding agent is altogether *sui generis*, and characteristic of glacial action, and not at all that which could be effected by dragging masses of ice over the sea-bottom. This in itself is a conclusive refutation of the theory. The record made by a glacier

* See position of northern lakes on map.

is unmistakable, and no one who has not learned the language in which it is written is warranted in taking part in the discussion ; but he who has done so will find graven on the rocks of the Alps, the hills of New England, the basins of the Great Lakes, and the mountains of Colorado and Oregon, an inscription which is everywhere the same, which can have but one meaning, and bears a signature that can not be counterfeited.

While it is hopeless to expect that all men will agree upon this—or any other—subject, I think I am justified in saying that the facts which have been stated, and others of like import, constitute an indisputable record, not necessarily of the former existence of a great ice-cap over all the northern regions, but of the simultaneous prevalence of sheets of land-ice, i. e., glaciers, over great areas of our continent ; and that these glaciers, forever in motion, holding imbedded in their substance sand, gravel, and bowlders, pressed against the underlying rock by their enormous weight (probably averaging fifty thousand pounds to the square foot),* became powerful agents of erosion ; general and uniform when they were broad, narrow and special when they were local. This is the reading of the facts now given by those who are best qualified to judge of the import of the phenomena in the Old World and in the New. Already the belief in an ice period and ancient glaciers is general—hereafter, with more complete knowledge of the subject, it must become universal.

Accepting the facts cited above as demonstrating the truth of the glacial hypothesis, and as proving beyond cavil the reality of an ice period, we now pass to consider the proximate and remote causes of the distinctive phenomena of this remarkable chapter in geological history.

With characteristic conservatism Lyell endeavored to account for the prevalence of glaciers over the northern hemisphere by supposing them to be due to a peculiar arrangement of land and sea ; broad and elevated areas of land in the Arctic regions, low and narrow land surfaces in the tropics. I have elsewhere † discussed this question at some length, and have shown that this theory is untenable, because : First, during the Tertiary age the land was high at the north, no marine Tertiary deposits being found there ; Asia, Europe, and America were then connected by land, and the tropical currents were excluded from the Arctic Ocean, ‡ but in that age a warm climate

* Fifty-four thousand eight hundred and ten pounds for one thousand feet in thickness ; in some cases (around Mount Washington), probably two hundred and fifty thousand pounds.

† "Popular Science Monthly," July, 1876.

‡ At least through the channels of the North Pacific or North Atlantic. It has been suggested that in the Tertiary ages a communication existed between the Mediterranean and the Arctic Ocean by way of the Caspian Sea, Sea of Azov, etc. ; but if there was an open channel across Western Asia at that time—which has not been proved—it could hardly have been broad and deep enough to permit a flow through it *both ways* (for no other channel is known) of sufficient volume to modify the climate of the Arctic regions.

prevailed over all the Arctic regions. At the same time the tropical lands were locally if not generally lower than now, since in the West Indies and on the borders of the Gulf of Mexico are broad sheets of marine Tertiary; Second, because all evidence is wanting of high northern lands during the ice period; and, at least during a portion of the time when an arctic temperature prevailed from New York northward, the sea stood much higher than now, receiving and precipitating the Champlain clays—the fine flour ground by the land glaciers—and burying in them arctic shells.*

In the article referred to I have shown that no terrestrial causes yet suggested are adequate to produce an ice period, and that we are compelled to look to some cosmical cause for an explanation of its occurrence.

Recently a voluminous and elaborate review of the subject has been published by Professor J. D. Whitney, with the title of "Later Climatic Changes," the object of which is to prove that there has never been an ice period, properly speaking. To establish this, it is claimed that ice has little or no eroding power; and the few ancient glaciers, of which the evidence can not be ignored or sophisticated, are considered as the products of local causes. Following Lecoq and others, Professor Whitney claims that since snow and ice are forms of moisture evaporated elsewhere by heat, the extension of glaciers at any time or place is simply an effect of increased evaporation—of heat and not cold—and hence if there ever was an ice period, meaning a time when glaciers were more widespread than now, it must have been a warmer period than the present; forgetting, apparently, that increased congelation is the only necessary feature in the increase of glaciers, for, without this, increased evaporation and precipitation would be inoperative. Only a few of many facts need be cited to show that this theory is untenable: 1. Glaciers are now confined to altitudes and latitudes where the temperature is low—Alpine summits and the Arctic and Antarctic Continents. To extend the reach of the glaciers now existing, and to reproduce them where they existed formerly but are now absent, it would be only necessary to widen and intensify the conditions upon which their existence depends, viz., lower the temperature and cause the present precipitation to be more generally fixed in ice and snow. A single example will be sufficient to prove the truth of this statement. On the Cascade Mountains in Oregon we find a copious precipitation of rain and snow, but no ice where great glaciers formerly existed. The snow-fall is so heavy that the snow-line is brought down to an altitude of seven thousand feet above the ocean, and there the temperature is high enough to permit the vigorous

* The Champlain clays about New York are near the present sea-level. At Croton Point they are 100 feet higher; at Albany, 200 feet; on Lake Champlain, 350 feet; at Montreal, 500 feet; on Labrador, 800 feet; on Davis Strait, 1,000 feet; and at Polaris Bay, 1,600 feet above the ocean.

growth of trees and smaller plants. The fir-forests here meet the snow-banks in actual mechanical conflict, and the front ranks of trees, though of good size, are weighed down by the snow and grow prone and interlaced upon the ground. The snow-fields rise three thousand to four thousand feet above the snow-line, and there are miniature glaciers at the heads of the valleys—representatives of the great glaciers that once filled these valleys to their mouths. The precipitation remains, the snow-fall remains, but the glaciers are gone. Here we have just the conditions most favorable to the formation of glaciers according to the theory of those who regard glaciers as *thermal phenomena*, but no glaciers—*because of the high annual temperature.* With an increase of the average annual temperature, even with increased evaporation and precipitation, it is evident that no glaciers would form ; but with a *depression* of temperature which should cause the rain-bearing winds from the Pacific to do all the year what they now do only in winter ; viz., heap up snow on the highlands ; and some of this snow-fall should accumulate year after year, the mountain-slopes and draining valleys would soon be occupied by glaciers, as they were in former times. So if winter conditions could be made permanent on the great water-shed of the Canadian highlands, and the water of the St. Lawrence, the Mississippi and Red Rivers were retained in the form of snow and ice, glaciers would fill again the lake-basins, override the highest summits, and cover with an ice-sheet all the old glaciated areas.

Even if the evaporation from adjacent seas were somewhat diminished by the cold, that would not change the result, though it would prolong the time. The evaporation from the ice-cold oceans in the regions surrounding the north and south poles is now sufficient to produce continental glaciers in Greenland and on the Antarctic Continent, and it requires no argument to show that like conditions would produce like results in what is now the temperate zone.

On the theory that increased evaporation and precipitation would cause an extension of glaciers, and as an illustration of their local origin, it has been suggested that the water with which the dry regions of our Western Territories were once abundantly supplied produced the glaciers of which we find traces on the adjacent mountains, and the exhaustion of the water caused the disappearance of the glaciers. We shall see, however, that this is a speculation which is as yet sustained by no proof. It is well known to all geologists that the interior of the North American Continent has been occupied by a succession of great fresh-water lakes, extending in time from the early Eocene to and through the Quaternary. The history of these lakes has been admirably worked out by King, Gilbert, and Russell. Those of the Tertiary were numerous and broad, providing ample evaporating surfaces, but so far as we know they contributed nothing to the formation of glaciers—which could not have existed, indeed, under the warm sun of the Tertiary ages, except on mountains higher than any the continent now bears. In the Tertiary the climate was sub-tropical over all the area of the United States south of the British line, as is shown by the fact that palms and cinnamon-trees grew as far north as Vancouver's Island and the falls of the Missouri.

The relations which the great Quaternary lakes, Bonneville, La Hontan, etc., bore to the former glaciation of the adjacent mountains is an interesting subject of inquiry. As I have mentioned, it has been suggested that it is the relation of cause and effect, but this is supported by no proof, and opposed by strong circumstantial evidence. The lakes and the glaciers may have been synchronous, and, to some extent, co-operative phenomena; but the relationship was rather fraternal than filial, as they had probably a common parentage.

The cause of the former wide spread of water-surfaces in the undrained portions of the Great Basin was either more copious precipitation or less rapid evaporation than at present. It is well known that the supply of moisture of this region is derived from the rain-bearing winds which blow steadily on to the land from the Pacific, and "the testimony of the rocks" is conclusive to the effect that there has been no change in the outline or elevation of the land, or the relations of land to sea since the Tertiary age, which could have materially increased or diminished the precipitation.

So in regard to the topography of the interior. Since the end of the Tertiary it has remained essentially the same. The hydrographical basins have been filled and emptied, but the old beach-lines which mark their sides prove that the country has remained substantially undisturbed. It is apparent, therefore, that the causes of any variation in the amount of precipitated or accumulated moisture must be climatic and not topographical. King, Gilbert, and Russell have shown that there have been several alternations of wet and dry climate in the Great Basin, and they are substantially in agreement that there have been two wet and two dry periods, of which the last is the present.

It would seem easy to determine by observation the relationship between the lakes and glaciers of that region, since some of the glaciers descended far below the highest water-level, as was the case with the Little Cottonwood glacier, to which reference has already been made, but the actual contact of the glaciated surface and the lake sediments is there covered and concealed by modern *débris*. The observations made elsewhere by Gilbert and Russell will, when published, probably demonstrate that which can now only be conjectured. We can confidently predict, however, that it will be found that the same climatic condition which produced the accumulation of water in the lake-basins also caused the accumulation of congealed water on the highlands. A greatly increased rainfall might produce lakes without forming glaciers, but we appeal in vain to the facts or the imagination for a probable cause of an increased oceanic evaporation, with a more abundant precipitation on the land. Hence we seem driven to the acceptance of the other alternative—diminished evaporation—for the filling of the reservoirs of the Great Basin. And when we search for a cause of diminished evaporation only one presents itself, but that offers an easy and natural solution of the problem. A depression of temperature would certainly reduce evaporation (since the power of air to absorb moisture varies directly with the temperature), and at the same time form lakes in the valleys, and glaciers on the mountains. To prove this, we have only to cite the phenomena presented by summer and winter in the Western Territories. In winter the snow-fall on the highlands is heavy, and the accumulation of moisture in this form is large; the skies are cloudy, and the evaporation is small. In summer the sky is cloudless, the heat intense, evaporation and desiccation rapid. In the spring the snows melt, flood the valleys and form temporary lakes, which in midsummer dry up to *playas*. A climatic change which would perpetuate the conditions of winter and spring would inevitably produce glaciers and lakes, and these would be in the main synchronous; and thus all we find recorded in the past history of this region would be repeated. But to intensify and prolong the summer would not produce either lakes or glaciers.

From the facts which have been enumerated above, it will be seen that from all sides we get evidence confirmatory of the theory that a certain period in the history of this continent was marked by the spread of ice and snow over a very much larger portion of the surface than they now occupy; and that we are fully justified in designating this time as an ice or glacial period; also that this was a period during which, from some extraneous cause, the climate was made colder, and the conditions which now prevail on Alpine summits perpetually, and in winter elsewhere temporarily, were more wide-spread and continuous.

That the Ice period was cold and not warm is also proved by the presence of the remains of an arctic flora and fauna in all regions near the old glaciers; the arctic shells of the Champlain, the arctic plants in the Quaternary clays, the reindeer, the musk-ox, the woolly elephant, and woolly rhinoceros, all tell the same story.

On the preceding pages the Ice period is spoken of as a single geological epoch of the Quaternary age: and so it must be reckoned in any general division of geological time. But the evidence is conclusive that the Ice period was double; that is, there were two maxima of cold separated by a long interval in which the climate was ameliorated, and over large areas which had been for ages occupied by glaciers and snow-fields, the ice and snow were withdrawn, and the surface was covered with vegetation, again to be partially taken possession of by glaciers.

Just how far north the glaciers retreated during the interglacial warm period we do not yet know, but probably not far beyond the Great Lakes; since the vegetation which covered Southern Ohio, during the interval represented by peat-beds between the first and second bowlder clays, was that of a cool climate, and the interglacial beds have not been traced beyond Scarboro Heights, on Lake Ontario.*

Facts similar to those from which we have sketched the history of the Ice period in North America, observed in Europe and Asia, afford abundant evidence that the conditions which existed here prevailed over all the northern hemisphere. In South America also similar phenomena have been observed and reported by many geologists. Hence, any explanation offered of the records of the glacial period found here must be comprehensive enough to include the whole great field; and the difficulties which here oppose the acceptance of a theory that is only local in its scope, grow until they become insurmountable. That the conditions which prevailed simultaneously in different parts of the northern hemisphere during the Ice age were synchronous with similar conditions in the southern hemisphere is not proved, nor is it probable that it is susceptible of proof. By many, perhaps most geologists these conditions are supposed to have alternated at the north and south. This much, however, we are justified in asserting, that at an epoch holding the same relative position in geological history north and south of the equator, either simultaneously or alternately, cold climatic conditions prevailed in both hemispheres and left records that are alike in character and import.

An inquiry into the nature of the cosmical influence which we must credit with the phenomena of the Ice period would lead beyond the scope of this paper, and open questions too broad and suggestive to be settled or even adequately discussed in the space at our command. I shall, however, have accomplished the end I had proposed to myself if I have shown—1. That the Ice period was a cold period. 2. That the record of the Ice period on our continent is more complete and impressive than it has been represented to be. 3. That it is the product of general and not of local causes. 4. That these causes were not topographical or even telluric, but extraneous and cosmical.

The question here passes rather into the hands of the astronomer and physicist. The work of the geologist is done when he has shown that the complete solution of the problem does not lie within his domain; that no telluric agency is adequate to produce the phenomena; and that some cosmical cause, such as a variation in the heat radiated by the sun, as suggested by Newcomb, changes in the eccentricity of the earth's orbit, as advocated by Croll, or some other general and all-powerful influence, must be credited with effects as wide-spread and stupendous as those the Ice period has left behind it.

* Although this paper is limited in its scope to a consideration of the glacial phenomena of North America in the Quaternary age, and to certain erroneous notions which are entertained in regard to it, it may not be out of place to say that it is believed by many geologists that there have been several ice periods, and one at least as far back as the Permian epoch.

ORIGIN AND RESULTS OF SUNDAY LEGISLATION.

BY REV. A. H. LEWIS, D. D.

THE times demand a reconsideration of our Sunday laws. They are practically inoperative. There must be some essential reason for this, in the character of the people or in the character of the laws; perhaps both. Either the laws have a false basis, and can not rightly claim public regard, or the people are wickedly indifferent to rightful authority. This is true of the Church as well as the "world." To know the origin of these laws will help to solve the problem.

Sun-worship is the oldest and most wide-spread form of paganism. It reaches back to the prehistoric period. Under various phases it has always been the persistent foe to the worship of Jehovah. It was the prevailing and most corrupting form of idolatry which assailed the Hebrew nation. Its lowest form, Baal-worship, produced the deepest social and moral degradation. As the period of idolatry passed away, sun-worship assumed a less materialistic form, without losing the virulence of its poison. It lay in waiting, like a beast of prey, to corrupt Christianity, as it had already corrupted Judaism. Transferred from the East, and from Egypt, to Greece and Rome, it became popular, and great efforts were made under Heliogabalus and others, in the third and fourth centuries, to exalt it above all other religions. Indeed, Mithraicism came near gaining the field and driving apostolic religion out of the Roman Empire. It did corrupt it to an extent little understood.

Pagan Rome made religion a part of the state. Long before the advent of Christianity, the emperor, as head of the state and therefore of the Church—Pontifex Maximus—was accustomed to legislate upon all religious matters. He had supreme power in this direction. Scores of sacred days were set apart, under the pagan empire, upon which judicial proceedings and certain forms of work were prohibited. It was the settled policy of the empire for the emperor thus to determine concerning *ferial* days. Apostolic Christianity forbade all appeal to the civil law in matters of Christian duty. Christ and his apostles sought only the rights of citizenship at the hand of civil government. When these were refused, they gladly yielded, suffering persecution, unto death, if need be. Christ repeatedly declared, "My kingdom is not of this world." New Testament Christianity could not have instituted such a cultus as that which gave rise to Sunday legislation, the union of church and state, under an emperor or an emperor-pope. "Old Mixon" peach-trees can not bear crab-apples. All civil legislation concerning religious faith and practice, such as obtained in the Roman Empire, was the product of paganism. It was not an offshoot of Christianity, or of the Hebrew theocracy.

The first civil legislation concerning Sunday appears in the edict of Constantine the Great, 321 A. D. Nothing appears in history as demanding the legislation, or as wishing it, except the will of the emperor. He was a well-known devotee of the sun-god, as were his predecessors. His attitude toward Christianity, both before and long after the issuing of the Sunday edict, was the attitude of a shrewd politician; toward his rivals it was that of an unscrupulous, bloody-handed monarch. He gained power by intrigue, deceit, and murder. No accurate historian dares call him a "Christian emperor." Romish tradition and superficial literature have misnamed him the "first Christian emperor." The facts relative to his life and character forbid every such claim. He refused to unite with the Christian church until he lay on his death-bed, in 337 A. D., when he received baptism, hoping thus to make the most of both worlds. The text of his Sunday edict, and the surroundings, all show it to have been purely heathen. The text is as follows:

"Let all judges, and all city people, and all tradesmen, rest upon the *venerable day of the Sun.* But let those dwelling in the country freely and with full liberty attend to the culture of their fields; since it frequently happens that no other day is so fit for the sowing of grain or the planting of vines; hence the favorable time should not be allowed to pass lest the provisions of Heaven be lost.

"Given the 7th of March, Crispus and Constantine being consuls, each for the second time."—("Codex Justin.," lib. iii., tit. 12, l. 3.)

If the foregoing law were associated with Christian laws, the testimony against it would be less damaging. But the following shows that on the next day Constantine issued another edict, which, like the above, is unmixed paganism.

Edict concerning haruspices:

"The august Emperor Constantine to Maximus:

"If any part of the palace or other public works shall be struck by lightning, let the soothsayers, following old usages, inquire into the meaning of the portent, and let their written words, very carefully collected, be reported to our knowledge; and also let the liberty of making use of the custom be accorded to others, provided they abstain from private sacrifices, which are specially prohibited.

"Moreover, that declaration and exposition written in respect to the amphitheatre being struck by lightning, concerning which you had written to Heraclianus, the tribune, and master of offices, you may know has been reported to us.

"Dated the 16th, before the kalends of January, at Seridica (320), Acc. the 8th, before the ides of March, in the consulship of Crispus II and Constantine III, Caess, Coss., 321 A. D."—("Codex Theo.," lib. xvi, tit. 10, l. 1.)

The reader will note that nothing appears in the law, neither does anything appear in the accompanying evidence, showing that Christians desired the law, or were in any way interested therein. It applied to all the subjects of the empire alike. The day is not mentioned, except by its heathen title. There is nothing in the restrictions placed upon it unlike the restrictions which already existed concerning many other pagan days. The following extract, from the work of an English barrister, is pertinent at this point :

"That the division of days into *juridici et ferati*, judicial and non-judicial, did not arise out of the modes of thought peculiar to the Christian world, must be known to every classical scholar. Before the age of Augustus the number of days upon which, out of reverence to the gods to whom they were consecrated, no trials could take place at Rome, had become a resource upon which a wealthy criminal could speculate as a means of evading justice ; and Suetonius enumerates, among the praiseworthy acts of that emperor, the cutting off from the number thirty days, in order that crime might not go unpunished nor business be impeded."—("Feasts and Fasts," p. 6, by Edward V. Neale.)

After enumerating certain kinds of business which were allowed under these general laws, Mr. Neale adds, "Such was the state of the laws with respect to judicial proceedings while the empire was still heathen." Concerning the suspension of labor, we learn, from the same author, that—

"The practice of abstaining from various sorts of labor upon days consecrated by religious observance, like that of suspending at such seasons judicial proceedings, was familiar to the Roman world before the introduction of Christian ideas. Virgil enumerates the rural labors which might on festal days be carried on without intrenching upon the prohibitions of religion and right ; and the enumeration shows that many works were considered as forbidden. Thus it appears that it was permitted to clean out the channels of an old water-course, but not to make a new one ; to wash the herd or flock, if such washing was needful for their health, but not otherwise ; to guard the crop from injury by setting snares for birds, or fencing in the grain ; and to burn unproductive thorns."—(Ibid., p. 86.)

Sir Henry Spellman, speaking of the origin of English "court terms," says :

"I will, therefore, seek the original of our terms only from the Romans, as all other nations that have been subject to their civil and ecclesiastical monarch *do* and *must*.

"The ancient Romans, while they were yet heathens, did not, as we at this day, use certain continual portions of the *year* for a legal decision of controversies, but, out of superstitious conceit that some days were ominous and more unlucky than others (according to that of the Egyptians), they made one day to be *fastus* or *ferii day*, and another (as an Egyptian day) to be vacation or *nefastus ;* seldom two fast or law days together; yea, they sometimes divided one and the same day in this manner:

"*In modo fastus erat, mune nefastus erat.*

"The afternoon was term, the morning holy day. Nor were all their *fasti* applied to judicature, but some of them to other meetings and consultations of the commonwealth; so that, being divided into three sorts, which they called *fastos proprie*, *fastos endotercisos*, and *fastos comitiales*, containing together one hundred and eighty-four days, through all the months of the year there remained not properly to the prætor, as judicial triverbial days, above twenty-eight."—(Works, from original MS., in Bodleian Library, book ii, p. 74.)

Church historians have been obliged to recognize the purely heathen character of this legislation. Schaff says: "But the Sunday law of Constantine must not be overrated. He enjoined the observance, or rather forbade the public desecration, of Sunday, not under the name of *Sabbatum* or *Dies Domini*, but under its old astrological and heathen title, *Dies Solis*, familiar to all his subjects, so that the law was as applicable to the worshipers of Hercules, Apollo, and Mithras, as to the Christians. There is no reference whatever in his law either to the fourth commandment or to the resurrection of Christ."—("Church History," vol. iii, p. 380.)

Milman says: "The rescript, indeed, for the religious observance of the Sunday, which enjoined the suspension of all public business and private labor, except that of agriculture, was enacted, according to the apparent terms of the decree, for the whole Roman Empire. Yet, unless we had direct proof that the decree set forth the Christian reason for the sanctity of the day, it may be doubted whether the act would not be received by the greater part of the empire as merely adding one more festival to the *fasti* of the empire, as proceeding entirely from the will of the emperor, or even grounded on his authority as supreme pontiff, by which he had the plenary power of appointing holy-days. In fact, as we have before observed, the day of the sun would be willingly hallowed by almost all the pagan world, especially that part which had admitted any tendency toward the Oriental theology."—("History of Christianity," vol. ii, pp. 396, 397.)

No other legislation concerning Sunday appears for the next sixty-five years. Meanwhile, the Church was becoming paganized, the papacy was developing, the empire was tottering, and all things were getting ready for the dark ages. From the close of the fourth century to the close of the fifth the legislation was enlarged, including scores of other days, most of them pagan festivals, christened by new names, and but slightly modified in the manner of their observance. As church and state became more thoroughly united, the pagan idea that the civil law ought to regulate religious actions and religious belief was so fully developed that the state determined not only what men should do, but what men should believe. Civil law practically decided what Christianity was. It defined orthodoxy and heresy, thus involving the whole realm of religious conscience in the meshes of political intrigue.

As the Holy Roman Empire grew upon the ruins of the pagan empire, it continued to secularize and corrupt Christianity. Civil legislation relative to Sunday and other festivals and fasts prevailed during the dark ages. Our Saxon ancestors, converted under this empire, received this inheritance, and transmitted through the Saxon and English laws the entire genius of Sunday legislation to our own time. The chain is unbroken which binds the Sunday law of to-day to the first pagan Sunday law of 321 A. D.

There was little or no development of the Sabbatic idea, as drawn from the fourth commandment, until the time of the Puritan reformation. Under the theory that the fourth commandment might be transferred from the seventh to the first day of the week, Sunday legislation took on the more distinctively Sabbatic type which has prevailed in America. The theocracy of the New England colonies, which made the civil government subservient to the Church, instituted the most rigorous Sunday legislation. These early colonial laws were not only rigid, but were rigidly enforced. Their power was short-lived. As the colonial governments gave way to the States, and the States became united in the nation, Sunday legislation was continually modified and its influence steadily declined. The laws still exist, but are disregarded by all classes of society, according to choice or convenience. Religious men assemble in conventions, speak through resolutions, and editorials bewail the state of things and talk of the necessity of a more rigid enforcement of the Sunday laws. No one heeds such talk, and no law is enforced. Year by year we drift further away from a religious regard for Sunday. The most cogent arguments driven into the public mind are like a nail driven into the weak mortar of a thin wall; it looks well till you attempt to hang a weight upon it, when it gives way, deepening the sense of failure. Hence we say, as at the beginning, either the Sunday laws are not grounded in Christianity, or the public conscience has become wickedly indifferent.

WHY THUS?

The real philosophy of the situation is this: Sunday laws, coupled with the false no-Sabbath theories which were developed in the second century, have depraved the public conscience and produced the very results over which good men now mourn. Granted, for sake of the argument, that Sunday has rightfully taken the place of the Sabbath, and ought to be observed in accordance with a Christian interpretation of the fourth commandment. The fact remains that the civil law, assuming control of religious actions, places itself between the human heart and God. It shuts out the divine authority. It forbids the conscience to rise above the human authority. The result is, no conscience. If, on the other hand, the observance of the Sunday, or the enforcement of the law, be urged upon grounds of policy and expediency, each man instantly claims the right to judge for himself as to what is expedient or necessary. Divine authority alone can give a Sabbath. Human authority can give no more than a holiday.

The results which confront us indicate an underlying philosophy against which it is useless to fight. They show that the pagan conception, which makes the state the source of authority in religious matters, the arbiter of disputes, or the regulator of acts, is not only foreign to the true Christian conception, but is destructive of it. The Christianity of the fourth century was widely removed from the Christianity of the apostles. No one element did more to create this degeneracy than the interference by the state in matters of religion. No form of interference affected the life of the people more than legislation concerning holy-days and religious festivals. The effort which Puritanism made to lift the whole question to a higher level has failed because it persisted in the fundamental error that the state may justly legislate concerning religious duties. Religious sabbatizing is a duty which men owe to God alone. Civil law can make a holiday, can institute a day on which business and labor will cease; it can never make a Sabbath any more than it can make an honest man. All appeal to civil law concerning Sabbath-keeping is necessarily degrading, and opposed to the genius of Christianity. The Sunday laws have not become obsolete because men are comparatively more wicked than before, but because men have steadily risen above the pagan conception which permits the state thus to interfere. He who complains of the decline in regard for Sunday laws complains of an unavoidable fruitage which has always appeared and always will appear when the state interferes with religious matters.

Another result has developed in connection with our Sunday laws whereby the vilest and most nefarious business known to our civilization has intrenched itself behind them, and at the same time defies them. The enforced leisure which the Sunday laws and the customs concerning Sunday have brought about make Sunday the great harvest-day for the saloons and their associate evils. The Sunday laws prohibit many forms of legitimate business which our Christian civilization has come to allow, and any persistent effort to enforce the Sunday laws against the saloon is met by the saloonist with the counter-effort to enforce the laws against legitimate business. In the absence of any struggle with the saloon, nobody thinks of enforcing the laws against legitimate business, or against popular amusements. Meanwhile the rum-traffic, content to close the front door, if that be really insisted upon, goes forward, and will continue to go forward, unchecked. Legitimate business can not afford to be interfered with, and the liquor power, holding the club in its own hand, says, "Permit me to go forward, through the side-door at least, or I will give you endless trouble through the same law whereby you seek to interfere with me." In many places, as in our Western cities, the liquor power is strong enough to openly defy every effort, and to push its business through the front door, regardless of law. Between the two methods, the rum-traffic has taken full possession of Sunday, and the larger half of its profits are gathered in on that day.

A still more deplorable evil has come upon the Church itself, through reliance upon the Sunday law, and through the acceptance of Sunday, which has neither Scriptural authority nor standing-room on the law of God. It has ceased to appeal to the law of God—except in a very weak way—as the source of authority in matters relative to the Sabbath, and has thereby become shorn of all real strength. Year by year the Church drifts further into the stream of Sunday desecration. The pulpit talks of the terrible disregard for Sunday which prevails, while the pews hasten out on Monday morning to pocket the profits of Sunday business and Sunday revelry. Thus, dependence on the civil law, and false theories concerning the abrogation of the Sabbath, have turned the heart of the Church itself away from the law of God, and left it to lean on a broken reed which is piercing it through.

The results are sad, but terribly real. They are legitimate, unavoidable, but none the less ruinous.

THE MENTAL FACULTIES OF MONKEYS.

By Madame CLÉMENCE ROYER.

WHEN we compare the mental faculties and social instincts of animals, even of monkeys, with those of the superior races of civilized men, the distance seems immeasurable, and to fill the gap impossible. But, if we take the lower races of mankind, the differences appear less marked, and even analogies arise. Many of the moral and mental faculties, in fact, which we observe among the quadrumana appear common to them with savage peoples on the one side, and with some of the higher mammalia on the other side, which have well-developed social instincts—with, for instance, dogs, horses, and elephants. The animals which man has domesticated are, as a rule, those which belong to social species, and live in the natural state in more or less numerous groups. And, among the monkeys, it is not the large ones, those which most resemble men in stature, that are most social and most susceptible of domestication, but the smaller ones, the tree-climbers.

The gorilla, of Western Africa, lives in patriarchal and polygamous families, in which many females and their young submit to the authority of a single adult, and the habits of the chimpanzee are similar; but the *Cynocephalæ*, most of the smaller species of the African

Continent, and American monkeys, live in considerable troops, in a kind of general sexual promiscuity, in which the love of the mothers for their young, very strong while they need it in their weakness, does not outlive their growth out of helpless infancy. Similar habits have been noticed among some savage races; and traditions are preserved among many people of a time when family bonds did not exist. But traces of more durable family bonds between monkeys of the same blood seem to exist among the chimpanzees and gorillas, where the appearance of particular and exclusive affection is combined with rivalry with the members of other families. Savage, in the "Boston Journal of Natural History," tells of a female chimpanzee which was observed in a tree with the male and a pair of young of different sexes. She first started to hurry down and run into the thicket with the male and the young female; but, seeing the young male left behind, she went back for him and had taken him in her arms when she was shot. Houzeau, in his "Études" ("Studies on the Mental Faculties of Animals as compared with those of Men"), compares this trait with the indifference with which the New Zealand mother saw Cook take away her son, probably forever, as she was expressly informed. Houzeau also finds traces of paternal affection in the protection that old anthropoid apes accord to the members of the polygamous tribe of which they are chiefs. This kind of affection can, however, hardly be said to exist among all men. There are numerous tribes in which the fathers do not know their own children, in which the names pass in the female line, and where a man's heirs are the children of his sisters. Striking examples of conjugal love are sometimes shown among monogamous monkeys. An incident in point is that of a female of an American species which, tired of holding her young one, called up the male to relieve her. Another story is that of the male in the Jardin des Plantes which became inconsolable and starved itself to death after its companion died.

In the way of language, monkeys manifest their passions, emotions, desires, and fears, by cries and gestures, emphasized by significant accents, which vary with the species. Monkeys and children, together with savages and uneducated people of civilized nations, manifest an inclination to mimic the gestures and motions of all persons whom they see. We think that this trait is especially prominent in monkeys, but thousands of instances might be cited to show that mankind, old and young, shares it with them. The attitude and the sagacity of monkeys are so human that some savages believe that it is out of maliciousness that they do not talk. In fact, a monkey might pass for a dumb man, because he does not articulate the consonants clearly, as we do; but not all men have this power of articulation in an equal degree. We have stammerers by birth and by habit. Some savage tribes have a scanty alphabet complicated by clicks and nasal and guttural sounds that can not be imagined till they are heard. All monkeys have voices, and many of them have very strong ones. Excepting the solitary and taciturn orang-outang, the species which live in troops are chatterers, and keep up a great hubbub. The principal tones of their noisy and rapid language, with the frequent repetitions of the same sounds, may also be found in the languages of the most savage peoples. They are, for the most part, complex, guttural, and harsh articulations, with few variations. But the alphabets of some of the African and Melanesian nations are not much richer. In both, it is generally the labials which are wanting. Laughter is not wholly peculiar to men, for some monkeys have a noisy and expansive laugh analogous to ours. Cook has stated that natives of the New Hebrides express their joy by a kind of guttural whistle, analogous to the jerky, rattling laugh of some monkeys. Monkeys are also capable of showing sorrow and weeping; and it is possible to follow on their faces the equivalents of the physiognomical changes which in man answer to the expression of his various emotions. Among these are the drawing back of the corners of the mouth and the contraction of the lower eyelid, which constitute the monkey's smile, and the depression of the eyebrow and forehead in anger.

It can hardly be doubted at this day that monkeys have collective feasts, which Houzeau compares with the new-moon festivals of the negroes, Hottentots, and Papuans. Such assemblies take place among South American monkeys, when, having eaten up the resources of one place, they are about to emigrate to another. Duvancel witnessed, at Deobund, in India, a great meeting of monkeys, which the natives said took place regularly, after intervals of several years. They came up by thousands, from different directions, all marching with sticks in their hands. Arrived at the place of meeting, they threw their sticks into a great pile.

The feasts of the black chimpanzees of Africa are more like those of the negroes. The animals come together, it may be, fifty at a time, leaping, shouting, and drumming on old logs with sticks which they hold in their hands and feet. They are taking their first lessons in music, as it were; and it is remarkable that that music is upon the most rudimentary form of a drum, which is, besides, the universal primitive musical instrument of the lowest savage human races, and the only one which many of them possess. Tamed monkeys can beat the drum and play with castanets.

If we may believe popular stories, the quadrumana have some kind of funeral ceremonies. The Chinese Pharmacopœia speaks of a species of which, when any one of the band dies, all the others attend his funeral. A somewhat similar story, in which the dead monkey is covered with branches of trees, is told in "Purchas's Pilgrimmes"—a work which, however, is not of the highest scientific authority. But, however exaggerated these stories may be, it is not probable that monkeys are wholly indifferent to the death of their fellows—at least that they are less concerned than those Caffres who bury only the bodies of their chiefs and their children.

Leadership among gorillas is decided by the law of the strongest. When the young gorillas become able, they put the old chiefs out of the way, and themselves take their places. So savage tribes dispatch their old men when they are no longer of use, or when they stand in the way of some ambitious aspirant. Monkeys fight by striking and clinching with their hands, and by trying to bite; they will clinch one another just as athletes do. The gorilla, coming down on its enemy, utters a cry like the war-cry of savages, and strikes upon its chest with its hands, as Houzeau says athletes frequently do. When attacked by an armed man, it aims to seize his gun or his club, and having got it tries to break it; but it does not try to use it as the man does. Other monkeys try to avoid man, but when attacked by him defend themselves courageously and throw stones and sticks at him; if they are on trees, breaking off limbs and fruits and nuts, and whatever they can put their hands upon. The primitive arms of mankind are likewise projectiles thrown by the hand like the Australian boomerang and the Indian's tomahawk, club, or lance. Free as monkeys are in throwing sticks, they do not seem to have ever come to the point of using their weapons as clubs or lances; and it is not consistent with their organization and habits that they should do so. Their fortresses are tree-tops, from which flying sticks and stones can do great execution, but to fight with clubs and lances they would have to stand upon the ground, where they would be at a great disadvantage. Both races, then, have chosen or evolved the weapons best suited to their anatomical organization. The habits of street-boys still show that man's first weapon-using instinct was to throw stones; and with this in view we can fancy the early battles when throngs of men fought by throwing showers of stones up into the trees at the monkeys, who, in their turn, threw branches down at them. Very few animals besides men and monkeys throw projectiles, but that is because they are the only ones that have prehensile hands. But elephants when angry will break down branches and pull up saplings with their trunks; and the ostrich kicks stones behind itself at the faces of its pursuers. It is the anatomical organization of the animal that determines its choice of arms.

Monkeys are susceptible of showing spontaneous preferences and friendships for others, even outside of their species, and can be, in their affections for human companions, as capricious as children. They share in man's aversion to snakes. In a state of nature they appear to manifest aversion and hostility to other animals, and particularly to other species of quadrumana. Orang-outangs exhibit an instinctive animosity against other monkeys, and assail them in every way. The tribe as a whole exhibit anger by nearly the same kind of acts as men do. A chimpanzee of Du Chaillu's had marked preferences for particular things that were served at the table, and, when given other than what it desired, became irritated, threw down what was offered it, stamped its feet and uttered a peculiar cry, and acted, Du Chaillu says, just as a spoiled child would have done. A friend of the author, who had a little monkey, and was studying its instincts, said of it : "It is a badly brought-up child. It has all such a child's faults, and is intelligent enough to know when it is disobeying, and to hide itself when it intends to disobey." Dr. Abel's orang-outang showed its anger, when refused what it wanted, by rolling on the ground like a mad child and screaming, and would then go off and hide. The apes which Adanson chased in the forests of Senegal knit their eyebrows, gritted their teeth, and screamed ; and the monkeys in the Jardin des Plantes and the Jardin d'Acclimatation, when irritated by the refusal of anything that has been tantalizingly shown them, throw themselves upon the gratings, make their ugliest faces, show their teeth, and scream and mutter.

"Greedy as a monkey" is a vulgar expression. Houzeau says that those persons who assert that monkeys will not have to do again with intoxicating drinks after having once been made their victims were more desirous of teaching a moral lesson than of telling the exact truth. Most tamed monkeys are ready enough to drink wine and brandy, and will help themselves to them. They like to get tipsy, and will indulge themselves whenever they can, in spite of chastisements. Their intoxication is characterized by the same symptoms as man's—weak knees, thick tongue, and unsteady movements. This identity of the effects of intoxication extends to other animals : asses and horses have been seen drunk ; and dogs, which generally refuse wine, can be made to accept alcoholic drinks if they are sufficiently diluted and sweetened ; while, as we have seen, monkeys of different species often exhibit antipathies to one another, those of the same species will assist one another, provided they are not sexual rivals. This trait of mutual helpfulness appears to exist in all animals that have organs of prehension—as among the climbing birds and those insects which have mandibles. The instinct is quite well developed among monkeys, and those of the same family or troop exhibit traits of mutual assistance that might be very properly compared with those shown by men in their relations with one another. The monkeys in Sumatra, according to Cesare Moreno, are very troublesome in the gardens, and even in houses, when they can find entrance into them ; and no kind of inclosure seems adequate to protect fruits and vegetables from their depredations. Forming a line in order to pass their spoil from hand to hand, they scale the walls, enter at the doors or windows, and leisurely pillage all that they can find. Then they retire to the woods, to dress themselves up in the gayly colored cloths which they may have stolen, while they have a particular fancy for whatever will give a metallic reflection. They will divide their trinkets among one another, or quarrel about them, and dress themselves up in them in a grotesque style; and then, like children, having become tired of them, will leave them hanging on the branches or let them fall to the ground, and care no more for them. They seem to be thieves by instinct, for the mere pleasure of stealing, when they are not catering to their appetites; and they are capable of sacking a house and carrying off everything movable in it with the system and concert of a band of robbers. They observe a kind of discipline in their operations, and post their scouts, to inform them in season when it is time to run away; and this, when warned, they can do with wonderful simultaneousness.

Ulloa saw monkeys joining hands, six or eight together, to ford rivers. Dampier tells a very interesting story of the performances in this line of the monkeys of the Isthmus of Panama. We can see monkeys repeating the same exercise on a small scale for amusement in zoölogical gardens.

Travelers say that monkeys take up those of their number which are wounded in their battles. Savage observed the same thing done for chimpanzees when they were shot, and says that, when the wound does not immediately produce death, his fellows have been seen to put their hands over it to stop its bleeding, and, if this did not succeed, to apply leaves and sod. Houzeau relates an analogous story on the authority of the New-Hebrides islanders.

As men appropriate particular territories to themselves to the exclusion of all others, so the larger monkeys will drive away other animals from grounds they wish to occupy, with an efficiency that speaks well for their discipline and tactics.

The acuteness of the perception of domestic animals to approaching danger is well known. Monkeys exhibit it in an equal degree. Le Vaillant says that the bavian which went with him into Africa was his most trustworthy guardian, and signalized the approach of the slightest danger, whether by day or by night, even before the dogs could discover it; while the dogs acknowledged it their superior in this faculty, and at its look or nod would spring to this side or that, according as it indicated. The same monkey, though tamed, would answer the cries of the wild ones of its species when it heard them in the woods, but was afraid of them when it saw them. All travelers testify to the intelligence of monkeys in a wild state, and have much to say of the trouble they have in guarding against their devices. It is not considered safe to attack their troops, for they will defend themselves in concert and with energy, and in apparent security, from the tree-tops, where they are afraid of nothing but a gun.

The curiosity of animals is not always passive, and the attentive attitude they show is not always the effect of astonishment. They like to imitate, and to imitate they must observe. An orang-outang in the Jardin des Plantes, in Paris, being one day visited by Flourens and Geoffroy Saint-Hilaire, observed the latter with earnest attention. As soon as it had thoroughly studied its visitor, it took a cane, bent itself over like an old man, and imitated his gait. Another orang-outang had learned how to get upon a chair and open a door-latch, which was otherwise out of its reach. The chair it was accustomed to use having been taken away, it went and got another from the corner, brought it to the door, and mounted it. Houzeau regards these facts as indicating the existence of an inventive faculty, of a decided intention looking to a fixed end, and a perception of the relation of cause and effect. A black chimpanzee of Buffon's knew how to unlock the door, and, if it did not find the key in the lock, would look for it. This monkey took its meals like a well-bred person, ate with a spoon and fork, used a plate, and served itself with wine. The anthropoid ape Mafuka, in the Zoölogical Garden of Dresden, knew all about the way to open the door of its cage. It would steal the key and hide it under its arm till it wanted to use it. At one time, after watching a carpenter at work, it got his gimlet and bored holes in its table. At meals it filled its own cup from the pitcher, and took care not to let it run over.

Mr. Cobs gave his young orang-outang half an orange, put the other half in a cupboard, and lay down on the sofa. Remarking some peculiarity in the movements of the orang, he pretended to be asleep. The animal came cautiously up to him to assure itself that he was asleep, then climbed upon the cupboard, took the rest of the orange and ate it, hid the peel carefully under the sticks in the fire-place, and then itself lay down. Such manner of action, says Tylor, can hardly be explained except by a train of thoughts supposing the existence of what among ourselves we call reason.

Bennett had to chide a young gibbon many times for putting things out of their places, among other things a cake of soap. One morning when he was writing he observed the monkey taking the soap, and watched its operations in such a manner that he should not himself be observed. Seeing him apparently occupied with his writing, the monkey went off with the soap in its hand. When it had got to the middle of the cabin, Bennett spoke to it in such a manner as not to startle it. When it perceived that it had been seen, it returned and put the soap in very nearly the place from which it had taken it.

Monkeys seem well adapted to perform some kinds of domestic offices, and acquit themselves gracefully in them. The natives of Madagascar train the short-tailed lemur for hunting, where it renders the same services as a dog. Pyrard says that in his time the colonists of Sierra Leone employed chimpanzees in carrying water and beating in mortars. They would carry the water in jars on their heads, but would drop their burdens if some one was not at hand to relieve them from the load. Acosta tells of a monkey belonging to the Governor of Cartagena, which they were accustomed to send with a bottle and money to the wine-merchant's. It would never give up its money till it had got its wine, and would never touch that, although it was fond of it. Père Vincent Maria, procurator of the bare-footed Carmelites in the Indian Peninsula, tells of a *Macacus silenus* which imitated perfectly all the acts which it was shown how to perform. It would go at it so seriously and exactly that one could not help being surprised to see an animal do it all so well. Breton has in his Chinese pictures a representation of monkeys of one of the smaller species gathering tea-leaves on the tops of one of the steep ridges of Chansung. Williams doubts the truth of the story, but there is nothing in it outside of the probabilities. The ancient Egyptians obtained considerable services from the Cynocephalus.

Du Grandpré, of the French marine, speaks of a female chimpanzee that would heat the furnace on board the vessel. It was able to judge when the required degree of heat was reached, and would call the cook at the right moment. It would join the sailors in turning the capstan, would go on the yards with them, could pull ropes as well as any, and, observing that the ends were tied to keep them from hanging down, tied the ends which she held. Buffon mentions another female at Loango which could make the beds, sweep the house, and help turn the spit.

These monkeys had to be tamed before they could be taught; but, as they breed in captivity, Houzeau suggests that there is little doubt that the principal species are susceptible of domestication. Then it will only be necessary to train individuals for their special work. "Female monkeys," he adds, "might be employed in taking care of children. They would make excellent nurses, for their milk is rich in butter (ten per cent). These facts can hardly fail in time to strike the residents of European origin in Asia and Africa, where these animals are easy to get. We anticipate a time when these races, bred by man, will render great services in daily life and industry, and will contribute to the general progress. There is nothing in such a prediction which does not rest on scientific premises, and nothing in it to laugh at."—*Translated for the Popular Science Monthly from the Revue Scientifique.*

RECENT ADVANCES IN SOLAR ASTRONOMY.

By Professor CHARLES A. YOUNG.

WHILE during the past four years there has been no great or startling discovery in solar astronomy, there has been beyond question important progress at many points. Increased precision of numerical data has been attained, new methods of observation have been devised and put in practice, theories have been brought to trial with varying results of condemnation or approval, and mathematical and physical investigations have been initiated which give some promise of solving the mysterious problems of the sun's surface-drift, and the periodicity of the spots. We propose in this paper briefly to summarize these advances.

The transit of Venus on December 6, 1882, was widely, and, on the whole, successfully observed. The Americans alone used photography to any great extent, and at the nine different stations (four of them in the southern hemisphere) nearly fifteen hundred photographs were obtained, of which over a thousand are good for measurement. The German heliometer parties were also successful; and a great body of contact and micrometric observations and some photographs were obtained by French, English, and Belgian parties. The publication of the photographic and heliometric results is waited for with much interest, but, for some reason, has been greatly delayed. The general impression, however, is that the results will not prove as consistent and accurate as had been hoped, the probable error remaining still pretty large, and indicating that transits can not compete in accuracy with some of the other methods of determining the solar parallax.

Since 1882 the Washington experiments of Professor Newcomb upon the velocity of light have been completed and published, along with a new and independent determination by Michelson, at Cleveland. The anomalies in Newcomb's earlier observations were traced to their source and removed, and now the results of both observers stand in very close and gratifying accordance. Newcomb's is 299,860 kilometres, Michelson's 299,853.

To go with this in fixing the solar parallax, we have the new determination of the constant of aberration, by Nyrén, of Pulkova, based on all the Pulkova observations up to 1883. This value, $20''{\cdot}492$, combined with the above velocity of light, and with Clark's value for the earth's equatorial radius (6378·2 kilometres), gives for the solar parallax $8''{\cdot}794$—almost absolutely accordant with that deduced from the heliometer observations of Mars, in 1877. The observations of the eclipses of Jupiter's satellites, by Professor Pickering's photometric method, now in progress at Cambridge and Paris, will also give an extremely valuable result when the twelve-year cycle is completed. It has fixed the precise number of seconds required for light to traverse the mean distance between the earth and the sun.

The most remarkable result which has been arrived at, with reference to the solar radiation since 1882, is the fact, ascertained by Langley, that we do not receive from the sun any of the low-pitched, slowly pulsing rays, such as are emitted from surfaces at or below the temperature of boiling water. The solar spectrum appears to be cut off squarely at the lower end, and this cutting off we know can not have been effected in the earth's atmosphere, because we receive from the moon just the very kind of rays that are missing from the solar spectrum, and that in considerable quantity as compared with the rays of higher refrangibility. Langley finds these rays also abundant in the radiation from the electric arc, so that we can hardly suppose them *originally* absent from the solar energy. Unless there is some unsuspected error in the observations, it looks as if we must admit that they have been suppressed either in the atmosphere of the sun itself, or in interplanetary space.

Arrangements are now made by the English Solar-Physics Committee by which it is expected to secure at least one solar photograph, on a scale of eight inches to the sun's diameter, for every day of the year. These photographs are to be taken at Greenwich, at Dehra-Doon, in India; on the Island of Mauritius; and at some station in Australia: their comparison, measurement, and reduction are undertaken by the astronomer royal, at Greenwich. Much solar photographic work is also done at Potsdam and Meudon, but as yet nothing of the kind has been undertaken in the United States. Janssen has recently obtained some sun-spot photographs on a very large scale, but, so far as we know, they do not reveal anything new.

With the great twenty-three-inch telescope at Princeton, and on a few occasions, when the seeing has been fine enough to permit the use of powers of from six hundred and upward, the writer has found that, in many cases at least, the apparently club-like, almost bulbous, ends of the penumbral filaments are really fine, sharp-pointed hooks, reminding one of the curling tips of flames, or grass-blades bending over. Ordinarily they are seen as club-like, simply because of their brightness, and the irradiation and diffraction effects of moderate-sized object-glasses.

Some recent investigations upon the rotation of fluid masses, by Jukowsky, of Moscow, as applied to solar conditions by his colleague Belopolsky, seem to warrant a hope that the phenomena of surface-drift in longitude, and even the periodicity of the spots, may soon find a rational explanation as necessary results of the slow contraction of a non-homogeneous and mainly gaseous globe. The subject is difficult and obscure; but if it can be proved, as seems likely, that, on mechanical principles, the time of rotation of the central portions of such a whirling mass must be shorter than that of the exterior, then there will be, of necessity, an interchange of matter between the inside and outside of the sphere, a slow *surface*-drift from equator toward the poles, a more rapid *internal* current along and near the axis, from the poles toward the equator, a continual "boiling up" of internal matter on each side of the equator, and, finally, just such an eastward drift near the equator as is actually observed. Moreover, the form of the mass, and the intensity of the drift and consequent "boiling up" from underneath, might, and probably would, be subject to great periodical variations. Belopolsky's paper is given in the "Astronomische Nachrichten," No. 2722, and there is an English notice of it in "Nature" for May 20, 1886.

This theory falls in well with the facts established by Spoerer respecting the motion of the sun-spot zones, and the general, though slow, poleward movement of sun-spots.

Per contra, we have to note that Mr. Lockyer, in his recent lectures on solar physics, reported in "Nature," appears to be ready to accept the old theory that the spots, and their accompanying rings of prominences, are "splashes," due to the fall of meteoric matter upon the sun. He maintains that the spots appear *first*, and after them the faculæ and prominences; unless the writer is much mistaken, however, the reverse occurs sometimes, and even frequently—first faculæ and then spots among the faculæ.

The question of sun-spots and the weather is still debated with about the same vigor as ever; but, on the whole, there seems to be no reason to modify the opinions expressed in the text. While it is not at all unlikely that careful and continued investigation will result in establishing some *real* influence of sun-spots upon terrestrial meteorology, it is now also practically certain that this influence, if it exists at all, is extremely insignificant, and so masked and veiled as to be very difficult to determine. There is no ground or reason for the current speculations of certain newspaper writers who ascribe almost every great storm in the eastern part of the United States to some sun-spot or other.

The strange connection between solar disturbances and magnetic disturbances on the earth has, however, become more certain, if possible, than ever before, and is no longer anywhere disputed. In November, 1882, there was a very remarkable instance of an intense magnetic storm and polar aurora, simultaneous over all the earth, and coincident with the sudden outbreak of an enormous group of sun-spots.

Mr. Lockyer announces, as the result of a long series of observations upon sun-spot spectra, that there is a striking difference between the spot-spectra at the time of maximum and minimum sun-spot frequency; the lines that are most conspicuous by widening and darkening are by no means the same in the two cases. The most remarkable change is in the lines of iron, which are usually conspicuous, but almost vanish from the spot-spectrum at the sun-spot maximum.

The writer also has ascertained a curious and probably an important fact with reference to the structure of the spot-spectrum. Under extremely high dispersion it is found that the spectrum of the nucleus of a spot is not continuous, but is made up of countless fine, dark lines, for the most part touching or slightly overlapping, but leaving here and there unoccupied intervals which look like (and may be) bright lines. Each dark line is spindle-shaped—i. e., thicker in the middle where the spectrum is darkest and tapers to a fine, faint, hair-like mark at each end; most of them can be traced across the penumbra-spectrum, and even out upon the general surface of the sun. The average distance between the lines is about half that between the two components of b_3, so that within the b group the total number of dark lines is some 300, and there are seven or eight of the bright lines. This structure is most easily seen in the part of the spectrum between E and F; above F the lines are crowded so closely that it is difficult to resolve them, and below E they appear to grow wider, more diffuse, and fainter. It seems to indicate that the principal absorption which darkens the center of a sun-spot is not such as would be caused by minute solid or liquid particles—by smoke or cloud—which would give a continuous spectrum; but it is a true gaseous absorption, producing a veritable dark-line spectrum, in which the lines are countless and contiguous.

Since the notes to the second edition were written, great advances have been made in the study and mapping of the spectrum. While the maps of Kirchhoff and Ångström will always remain standards from the historical point of view, they are by no means adequate to represent what is seen by our present instruments, and a number of new ones have been recently constructed which must entirely supersede them for all detailed work. The most important of these are the maps of Thollon and Rowland. The former, for which its author received the Lalande prize of the French Academy of Sciences last January (1886), was constructed from *visual* observations with a great spectroscope having a train of his powerful compound bisulphide of carbon prisms. This map covers the whole length of the visible spectrum, and embodies the results of some two years' continuous labor; it was presented (as a drawing) to the Academy last year, but its engraving and publication are not yet completed, so that it will not be accessible for some time to come.

Professor Rowland's map is *photographic*, and extends from wavelength 5790, half-way between D and E, through the whole upper portion of the spectrum, and far beyond the visual limits. Its scale is from three to four times as large as that of Ångström. Five of the seven sheets are already published and in the hands of subscribers. The original negatives were made by means of a four-by-six-inch concave diffraction-grating, having about 90,000 lines, and a focal length of about thirty feet.

Professor C. P. Smyth, of Edinburgh, has also published a map of the whole visible spectrum, made with a very large diffraction spectroscope, having four-inch collimator and telescope, and a three-and-a-half by five-inch flat grating by Rowland. This map is constructed on a scale, not of wave-*lengths*, as usual, but of wave-*numbers*—i. e., the scale expresses for any given ray the number of its waves in the length of one "British inch." The dispersion is about the same as in Rowland's map. Important and very useful maps, on a slightly smaller scale, were published a year or two earlier by Fievez, of Brussels, and Vogel, of Potsdam.

In 1883 Egoroff, a Russian physicist, succeeded in showing that the great A and B groups of the solar spectrum are due to the *oxygen* in our atmosphere.

Cornu, by a very ingenious arrangement, in which he makes a small image of the sun, four or five millimetres in diameter, oscillate across the slit of a powerful spectroscope three or four times a second, has succeeded in bringing out conspicuously, and at a glance, the difference between the true solar and the telluric lines in the spectrum. The solar lines oscillate slightly as the eastern and western, the advancing and receding, limbs of the sun come alternately to the slit, while the telluric lines stand fast.

Mr. Lockyer has called in question the existence of the so-called "reversing layer" of the chromosphere, being disposed to hold that certain of the lines which we identify as belonging to the spectrum of any given substance, say iron, are due to absorption in upper and cooler regions of the solar atmosphere, while others are produced low down. In support of this idea, he adduces the observation that, at the Egyptian eclipse of 1882, certain of the so-called "iron-lines," between *b* and F, were much longer, though no brighter, than other "iron-lines" close by them, and remained much longer visible as the moon advanced to cover the chromosphere. There is not room to discuss the matter here. Those who believe that the Fraunhofer lines are mainly produced by that portion of the solar atmosphere which bathes and sustains the photospheric clouds, or lies immediately above them, would not quarrel with the idea that the upper regions also co-operate to a certain extent; but we see no proof from observation, as yet, that lines which are produced by the absorption of the upper regions of the solar atmosphere *are not also found in the lower.* The question undoubtedly is interesting and important: Does each region of the solar atmosphere have its own spectrum, peculiar and distinct from those of other regions above and below; all of them co-operating by simple summation to form the spectrum as we see it—or, on the other hand, as has been usually admitted, does the spectrum of the lowest stratum contain everything, while the spectra of the higher regions differ from it merely by defect? Eclipse observations may possibly decide it. Of course, if Mr. Lockyer is right, the fact would be a very effective argument for the theory of "compound elements," which theory, notwithstanding the failure of its "basic-line" defense, seems to be decidedly gaining ground in scientific opinion.

As to the bright-line spectrum of the chromosphere, no great discoveries have been made; a number of lines, probably fifteen or twenty, have been added by the writer to the two hundred and seventy-three long ago catalogued as constantly or occasionally appearing. Most of the new lines are in the violet and ultra-violet. Not one of them is below C.

Trouvelot has observed (or thinks he has) *dark* prominences—i. e., jets and clouds of hydrogen cooler than the luminous prominences, and so looking black when projected on a background of the hotter gas. Tacchini and Respighi have kept up a careful and systematic record of chromospheric phenomena in a statistical way.

During the past four years the most important investigations upon the solar radiation have been those of Langley. The results of the Mount Whitney Expedition of 1881, with those of certain supplementary investigations, were published in 1884. They fully confirm his earlier conclusion, that the previously received value of the solar constant should be largely increased, and from his data he fixes it at about thirty calories per square metre per minute instead of twenty-five. Of course, this involves a corresponding increase of twenty per cent in all the figures which are given to illustrate the immensity of the solar radiation in various ways.

It is worth noting also that Langley, following many French authorities, prefers to employ a smaller heat-unit than the *calory* used by the writer—the *gramme*-degree instead of the *kilogramme*-degree. His solar constant is the number of these *small* calories received per minute upon a square *centimetre*, and therefore on his scale of notation stands as three instead of thirty. We mention it, because this discordance in the definition of the calory has led to some confusion among those not entirely familiar with the subject. If we were to follow strictly the so-called c. g. s. system, the solar constant would be represented by a number still sixty times smaller—viz., 0·050 (gramme-degrees per centimetre per *second*).

Professor Langley has also, with the bolometer, carried the investigation of the invisible portion of the sun's heat-spectrum far beyond any of his predecessors, and has discovered and measured the wave-length of a large number of absorption-bands in this region; his results are confirmed by those of Becquerel and Abney, the latter operating by means of photography, and the former by means of the effect of the invisible infra-red radiations in quenching the phosphorescence of a suitably prepared screen.

Langley finds that the solar spectrum seems to terminate abruptly at a wave-length of about thirty thousand on Ångström's scale: he does not find in the sun's heat any of the long-waved, slowly-pulsating radiations, such as are emitted by bodies at or below the temperature of boiling water. We might think that they had been absorbed in the earth's atmosphere, were it not that he finds just these rays relatively abundant in the spectrum of lunar heat. He also finds them in the heat-spectrum of the electric arc, so that it is difficult to suppose that they do not *originally* exist in the solar spectrum. Unless there is some hidden fallacy or error in some of the observations, we are almost driven to admit that they have been absorbed in interplanetary space. But probably it will be best to await further confirmation of the experimental results before accepting so remarkable a conclusion.

At the eclipse of 1883, observed on Caroline Island, in the Pacific Ocean, by French and American parties, Professor Hastings made observations for the purpose of testing a theory he had framed that the outlying regions of the corona are merely a *diffraction* effect produced by the edge of the moon; the diffraction being not that due to the *regular* periodicity of light-vibrations, ordinarily discussed, but due to the probable continually occurring *discontinuity* or change of phase in the vibrations. It seems probable, from a not perfectly complete investigation, that such discontinuity might scatter light far beyond the limits of ordinary diffraction. He found during the eclipse, by an apparatus constructed expressly for the purpose, that the bright corona-line (1474 K) was always visible to a much greater distance from the sun on the side least deeply covered by the moon than on the other, as unquestionably ought to be the case if his theory were correct.

But the same thing would result from the diffusion of light by the air; and the French observers, and nearly all others who have discussed the matter, feel satisfied that this is the true explanation of what he saw. He himself now, we understand, thinks it not impossible that a thin cloud may have passed over the sun just at the critical moment, and so have vitiated his observation.

The discussion which has followed his publication seems to have only strengthened the older view, that the corona is a true solar appendage, an intensely luminous though inconceivably attenuated cloud of gas, fog, and dust, surrounding the sun, formed and shaped by solar forces.

The fact that comets, themselves mere airy nothings, have several times (the last instance was in 1882) passed absolutely through the corona without experiencing any sensible disturbance of path or structure, has, however, been always felt by many as an almost insuperable difficulty with this accepted theory, and more than anything else led Professor Hastings to propose his new hypothesis. But, on careful consideration, we shall find that our conceptions of the possible attenuation of shining matter near the sun will bear all the needed stretching without involving any absurdity. Recalling the phenomena of the electrical discharge in Crookes's tubes, it is clear that a "cloud," with perhaps only a single molecule to the cubic foot (but thousands of miles in thickness), would answer every luminous condition of the phenomena. And all the rifts and streamers, and all the peculiar structure and curved details of form, cry out against the diffraction hypothesis.

At present the most interesting debate upon the subject centers around the attempts of Dr. Huggins (first in 1883) to obtain photographs of the corona in full sunlight. He succeeded in getting a number of plates showing around the sun certain faint, elusive halo-forms which certainly look very coronal. Plans were made, and were carried out, in 1884, for using a similar apparatus upon the Riffelberg in Switzerland, and since then at the Cape of Good Hope. So far nothing has been obtained, however, much in advance of Dr. Huggins's own first results. But since September, 1883, until very recently, the air, as every one knows, has been full of a fine haze, probably composed in the main of dust and vapor from Krakatoa, which has greatly interfered with all such operations. It is now fast clearing away, and, if Dr. Huggins's views are correct, it is reasonable to expect that a much greater measure of success will be reached next winter at the Cape, and perhaps during the present summer in England and Switzerland.

About the same time that Dr. Huggins was photographing in England, Professor Wright, of New Haven, was experimenting on the same subject in a different way. He reflected the sun's rays into a darkened room by a heliostat, cut out all but the blue and violet rays by a suitable absorbing-cell, and then formed an image of the sun and its surroundings upon a sensitive fluorescent screen, stopping out the sun's disk itself. He obtained on the screen, on more than one occasion, what he then believed and still believes to be a true image of the corona. But the aërial haze soon intervened to put an end to all such operations; for of course it is evident that success, whether by photography or by fluorescence, is possible only under conditions of unexceptionable atmospheric purity.

Both Professor Wright and Dr. Huggins base their hopes upon the belief, which seems to be warranted by the spectrum-photographs obtained during the Egyptian eclipse of May, 1882, that the light of the corona and of the upper regions of the sun's "atmosphere" is peculiarly rich in violet and ultra-violet rays—that the corona is far more brilliant to the photographic plate and to the fluorescent screen than to the eye.

Probably it must be admitted that at present the predominant opinion among astronomers and photographers is against the practicability of reaching the corona without an eclipse, by any such methods; at the same time, to the writer at least, the case appears by no means hopeless, and success is certainly most devoutly to be desired.

P. S.—The reports from the recent eclipse of August 29th, observed by British and American parties on the Island of Grenada, in the Southern West Indies, have just come to hand, and are strongly unfavorable to the reality of the coronal appearances obtained by Huggins and Wright in their attempts to render the corona visible without an eclipse.

Plates furnished by Mr. Huggins, and precisely similar to those which he has employed in his photographic experiments, were exposed by Captain Darwin during the totality (as well as before and after it), in an apparatus like Mr. Huggins's, with a time of exposure the same that he has been using, and were treated and developed according to his directions. The plates exposed during the totality *show no corona* *at all*, the exposure proving insufficient to bring it out. Of course, this makes it extremely probable that what looks like the corona upon plates exposed to the uneclipsed sun is merely a fallacious ghost, due, as his opponents have always claimed, to something in his apparatus or process, or else to the scattered light in our atmosphere.

It is true, as Mr. Common points out, that the air was by no means satisfactorily clear during the eclipse, and the result, therefore, is not absolutely conclusive: but it must be conceded, and Mr. Huggins himself admits it, that the probability is now heavily against him.

Captain Darwin obtained good pictures of the corona with ordinary plates exposed for a longer time in the usual apparatus.

October 1, 1886.

CHEVREUL AT A HUNDRED.

By WILLIAM H. LARRABEE.

THE occasion of M. Chevreul's completing the one hundredth year of his age was celebrated in Paris on the 30th and 31st of August, with appropriate observances and honors. The festivities were begun in the National Society of Agriculture, whose custom it has been to elect M. Chevreul its president every other year. A committee of this society had been formed in April, under the presidency of M. Charles Brongniart, and had collected the sum of fifteen thousand francs for the purpose of striking a commemorative medal for the centenary. Addresses were delivered by Deputy Louis Passy, and, in presenting the medal, by M. Brongniart, who assured M. Chevreul that he was the object of the respect and admiration of all civilized nations. M. Chevreul replied ; "All that I have heard causes me much embarrassment. And why? On account of the warmth of the profound and numerous sentiments which you have expressed. I never anticipated the honor that my comrades have paid me."

In the Academy of Sciences, whose regular meeting took place on the 30th, M. Blanchard, in the absence from Paris of President Admiral Jurien de la Gravière, took the chair and made the Academy's address. He remarked upon the session's occurring on that day, as if the hour had been chosen for the event, saying that "in the family it is on the eve of the marked day that the festival is given : was it not fitting that it should be the same in the Academy, our intellectual family, which we love more and more as we grow older?" He referred to the fact that he had, as President of the Academy, predicted this very event three years before, when M. Chevreul was entering upon his ninety-eighth year. Then, having made a general mention of the value of M. Chevreul's discoveries, he said : "The investigator, absorbed in his mission, dreams of nothing but of extending its domain. If he succeeds in unveiling facts of considerable interest, he deserves well of science. If an application capable of furnishing the country a new source of wealth arises out of his labors, it is a glory to him; but the man of science finds his highest recompense when he has succeeded in spreading a comfort through the nation, and procuring for those who are disinherited of this world's goods a little of the luxury which it had seemed could only be obtained with wealth. Master, experimenter, philosopher, Monsieur Chevreul, you

Chevreul at the Age of Fifty.

have known all of these triumphs. Again I tell you, nothing is wanting to the fullness of your life. By your stories of remote events of which you have been a witness, you have charmed those who in age might be your sons, and those, still more numerous, who might be your grandsons. Your memory, yet in its freshness, permits you still to instruct those who might be your great-grandchildren. After to-morrow, you will count the days, weeks, and years of your new century. That the years may be many is the wish of your fellows and admirers." M. Chevreul in reply cited as a proof that a man's reputation depends greatly upon the trial of time, the examples of Newton and Leibnitz, the latter of whom said, "Seek first the demonstration of causes." "Newton preferred the more fruitful idea, 'Seek the cause of phenomena, and when you have found it inquire what is the cause of that cause.' There is a wide gulf between the two formulas. To my mind Newton is greater than Leibnitz. Time has proved it." Representative scientific men of other countries, commissioned to pay their respects to M. Chevreul, were introduced to him: M. Van Beneden, from Belgium; M. Broch, from Norway; M. Bosscha, from the Netherlands; and M. Govi, from Italy. A congratulatory telegram, expressing a warm wish for health, vigor, and force, "to that remarkable patriarch of the world," was read from the University of Kazan, in Russia.

M. Pasteur, who was absent in the Jura, sent his compliments to the veteran, who, he said, while he modestly called himself the dean of students, ought to be styled the master of masters.

The Academy of Sciences of Berlin sent a congratulatory communication which, after reference severally to the more important results of M. Chevreul's principal researches, concluded: "Having thus represented in all its extent the activity that you have shown throughout your long life, we hold that your name should be inscribed in one of the first places on the list of the great men who have carried the scientific glory of France to the extremities of the earth."

In the evening M. Chevreul attended the opera, to witness a special performance in his honor.

The anniversary day itself was signalized by the unveiling, amid considerable pomp and ceremony, of a statue of M. Chevreul by M. Guillaume, in the hall of the new museum at the Jardin des Plantes. M. Chevreul entered the room leaning upon the arms of M. Bourlois, aged ninety-four, an old soldier of the empire, and of M. Frémy, the director of the museum. M. Frémy delivered the presentation address, a glowing eulogy of M. Chevreul's work. M. Zeller, President of the Five Academies, followed him, and expressed his satisfaction that in that magnificent hall, in which so many friends and foreigners had met, the French "Grand Old Man," who had modestly called himself the *decanus* of the French students, had been promoted by acclamation as the *decanus* of the students and *savants* of the universities and academies of the whole civilized world. M. Goblet, Minister of Public Instruction, spoke next, and, after referring to the fitness of the place for the statue, said M. Chevreul's life "has been one of incessant labor. He has loved work for its own sake, with a conscientious and disinterested affection; and by a just return he has obtained from it all the satisfaction which it could give—health, peace of mind, honor, and the delight of making great discoveries."

M. Janssen delivered the formal address of the Academy at the Odéon. He said, "It belongs to the Academy to tell you that if Science to-day lifts you upon that beautiful pedestal, it is because you have constantly loved her for herself, and have never thought of making of her a stepping-stone for your own advantage."

In the evening M. Chevreul attended a banquet which was given in his honor at the Hôtel-de-Ville.

Various testimonials were presented to the centenarian during the days of the festivities. Among them was a volume published expressly for the occasion by M. Alcan, entitled "Hommage à M. Chevreul," written by Berthelot, who also presented a copy to the Academy, Charles Richet, Pouchet, Grimaux, E. Gautier, Dujardin Beaumetz, and Demarçay. The inhabitants of the Rue Chevreul sent him a fine nosegay. Another deputation presented him with a nosegay which, according to M. H. de Varigny's description in "Science," "was a masterpiece of art in the choice and distribution of colors. No more delicate allusion could be made to the venerable master's theory of complementary colors; and it was understood by the whole crowd, being exemplified in an unparalleled manner."

M. Gaston Tissandier has published in "La Nature" some incidents relating to M. Chevreul's career, additional to those which we gave in our sketch of him in August, 1885, or which throw a fuller light upon the facts presented in that article.

The life of the old philosopher has been up to this time spent between the Museum of Natural History, the Gobelins, and the Institute of France, and he has very seldom failed to be present at the Monday meetings of the Academy of Sciences. The memoirs which he has presented to his colleagues can hardly be counted. Among them may be mentioned one which he published in 1832 on the divining-rod, and another in 1853 on the tipping-tables, in which he scattered as with a breath all that was mysterious about the manifestations; and he rendered to science the service of demonstrating how the operator is the dupe of a charlatanism of which he is often the involuntary accomplice.

Although M. Chevreul had no taste for politics, he has been a man among his fellow-men, and a true patriot. During the Franco-Prussian War, when he was eighty-six years old, he remained in Paris through all the privations of the siege, and even stuck to the museum while more than eighty Prussian bombs were whizzing through it, making rubbish of the galleries and breaking up the glass cases. More than one of these projectiles burst close to the laboratory in which the brave old man was engaged in his work. He filed an indignant declaration of protest respecting this outrage, in the minutes of the Academy of the 9th of January, 1871, which runs as follows:

"The Garden of Medicinal Plants, founded in Paris by the edict of King Louis XIII, in the month of January, 1626—become the Museum of Natural History by decree of the Convention, on the 10th of June, 1793—was bombarded, in the reign of William I, King of Prussia, the Count of Bismarck being Chancellor, by the Prussian army, on the night of the 8th and 9th of January, 1871. Till then, it had been respected by all parties and by all powers, national and foreign.

"E. Chevreul, *Director*."

It was on the occasion of this declaration that M. Chevreul wrote to the Abbé Lamazon a letter in which he designated himself the dean of students, and thus gave origin to a title which has become famous in connection with his name. He said, "Let the expression of the sympathy you offer be given, not to the man of science, but to one who might call himself the Dean of the Students of France, since it has been given to him to continue without interruption, on the banks of the Seine, studies which were begun at the end of the last century in the beautiful land of Anjou."

M. Chevreul has a considerable library at the museum, which has been regularly increased by the accession of valuable books which his son, a bibliophilist like himself, has helped him to find. His grand life has been engaged in thought, and concentrated upon the studies from which such useful discoveries have resulted. He has kept himself in good condition and happy by work and moderation. His wife, who has now been dead for more than twenty years, attended to his comforts with all the devotion which such superior minds are able to invoke. His only son, a retired magistrate, lives at Dijon. The illustrious old man lives, therefore, alone, with his books for companions, by the aid of which he is able to converse with his brethren, the great ones of mankind, the Newtons and the Galileos. When not among his books, he is at his laboratory in the Gobelins, where he goes on with his experiments with a dexterity still quite juvenile.

M. Chevreul possesses a large fortune, which is augmented from year to year by the rewards of his scientific labors. His life therefore passes along placidly, enlivened by the pleasure of seeing the closing years of his career emphasized by ovations to his merit. He has witnessed the birth of all the scientific discoveries of our century, and has beheld the marvelous spectacle of the development of modern industry.

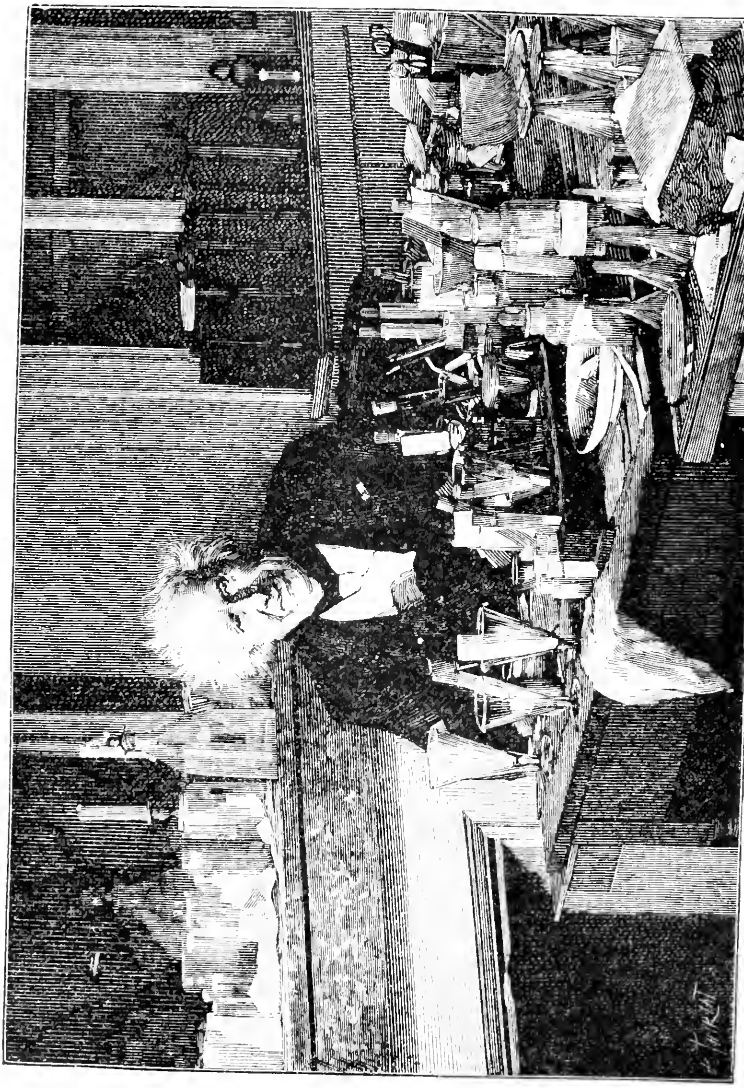
M. Chevreul is tall, and bears to this day an erect body. Of elegant manners and incomparable affability, he rarely fails to receive you with a smile. His head is a very fine one, with a broad and massive forehead, shaded with white locks. He is a man of wit as well as of genius. Recently, when engaging a new preparator for his laboratory, he said to him: "You must have a good deal of courage to take this place; I have killed four preparators already." We recollect, says M. Tissandier, seeing him at a ball in the Élysée, at midnight of a winter night, fresh and lively, surrounded by ladies whom he was gayly entertaining, with an exquisite and charming grace.

M. Chevreul is very sober. He drinks nothing but water and beer, except that, by the special request of Minister Goblet, he for the first time in his life departed from his abstinence to drink a glass of champagne in response to the sentiment "Vive la France!" at his century-banquet; and to his temperance, with his robust constitution and his prudent, regular, and industrious life, he doubtless owes his survival to so high an age.

It is a grand and beautiful spectacle, M. Tissandier concludes, that

M. Chevreul gives us, like that of an old oak overshadowing generation after generation of younger trees.

A partial conception of the length of M. Chevreul's still useful activity, and of the extent of his contributions to human welfare, may be gained by recollecting that, his first important work having been



M. Chevreul in his Hundredth Year at Work in his Laboratory. (From a photograph by M. David.)

published in 1806, he has been engaged for more than eighty years in fruitful investigations. As early as 1825, or sixty-one years ago, he was spoken of in "The Lancet" (May 28th) as "one of the most able chemists of the present day in France." He was then pursuing his studies in saponification, and had given to the world star or adamantine candles, which were a greater improvement over the tallow-dips and dim lamps which the common people of that day had to get along with than the electric light is over our gas-lights and petroleum-lamps.

An item recently appeared in the newspapers saying that the other day his Excellency Tcheou-Meou-Ki, Director of the Chinese Mission of Public Instruction, paid a visit, with the mandarins attached to his person, to M. Chevreul in Paris. He handed to the illustrious chemist a Chinese document expressing in old characters every wish for his happiness and long life. It appears that there is living at this moment in China a Chinese *savant* who at the age of one hundred years has just passed his examination, and been admitted a member of the highest academy of the mandarins. The interpreter explained to M. Chevreul that his Chinese visitors considered that the fact that two *savants* a hundred years of age were living, one in France and the other in China, was a link connecting the learning of the two countries.

A correspondent of the "Pall Mall Gazette" recently visited M. Chevreul in his study bedroom at nine o'clock in the evening. He found him in bed, reading a play of Molière's, "and as cheery and hearty as a young man of twenty. He has decidedly an ancient look about him. His skin is well furrowed and wrinkled, and his hand shaky; but his eyes are not dim, nor is his natural mental strength abated. His memory is something marvelous. He remembered the horrors and bloody days of the Terror as vividly as the struggles and rise of the Third Republic." He talked about the theatres, Shakespeare, and Molière, whom, like a true Frenchman, he preferred, and added: "I don't know if among the English there is the same admiration for the classics as in France. We have always professed a great love for the classics, but the word 'classic' is too often applied to things that have nothing classic about them. Then we have other schools, the romantic and others. But I don't find much in recent writers. They have got a great many new words, but work on the old ideas. They keep on reproducing the old ideas over and over again, and do not give us many new thoughts." And he repeated several times, "It is very easy to give new names to very old things."

The old man, says the correspondent, "prattled on from one subject to another, speaking slowly and distinctly. 'We have in France,' he observed, 'a school that has a considerable number of adherents who say that man was descended from the monkeys. But if you accept that doctrine, you do away with the perfectibility of species.' M. Chevreul does not always lie in bed and read Molière. Until last December he went about as well as he had done fifty years before. Now he goes about the garden and the museums, attends the Academy of Sciences every week, and frequently reads papers; goes regularly to the meetings of the Agricultural Society and the offices of the 'Journal des Savants.' He always enjoys good health, and 'eats more than I do,' says M. Chevreul, *fils*." His temperance grew out of a repugnance which he contracted in youth to wines and liquors, and extends to smoking.

His favorite topic is colors, respecting which, our correspondent says, "he would insist on sitting up in bed and giving a demonstration on the propagation of colors. His strong point was that the 'colors are in us, and the cause in the things we look at' (*de hors*). Although he had talked a great deal during the day, there was no stopping him when once the started on the color question, or getting him to change the subject; and when we rose to leave, he protested that we were going away because his exposition wearied us." He is as earnest and enthusiastic a student yet as if he had another hundred years before him. "No man, perhaps, has seen his country pass through so many revolutions, and has lived under so many *régimes* as M. Chevreul. He remembers Louis XVI. His recollections of the Revolution and the Directoire are clear, though he was not then at Paris. He can call up pictures of the glory and the dignity of the First Empire. He has lived under the First Restoration, the Hundred Days, the Restoration of 1815, the Legitimist rule of 1830, the Republic of 1848, the Second Empire of 1852, and the Third Republic—in all eleven *régimes*, which is tolerably good for one lifetime."

The lesson has been drawn from M. Chevreul's life of what one writer styles "the physical wholesomeness of sustained labor." Cases of extreme longevity are usually found either among persons who live in almost complete inactivity of mind and are thus subject to no wear whatever from their nervous and intellectual faculties, or else among those who spend their lives in constant, vigorous thought. Persons of the class between these, who learn and pursue some business which in time becomes largely a matter of routine and ceases to call out exertion of the powers, usually die early, or at a moderate old age. Hence, the wonderful brightness and activity which we sometimes admire among very old persons, is not so wonderful after all, but is a part of their old age, and one of the causes that have enabled them to enjoy it. And the general rule is sustained, in the case of M. Chevreul, as in the case of numerous other men who have served the world or are serving it at ages far beyond threescore and ten, that "the harmonious development of all the many-sided aspects of man is the most conducive to the health of the individual, and that the training of the brain may be as valuable as the training of the muscles."

GEOLOGY OF THE ATLANTIC OCEAN.*

By Sir WILLIAM DAWSON,
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I.

THE geological history of the Atlantic depression of the earth's crust, and its relation to the continental masses which limit it, may furnish a theme at once generally intelligible and connected with great questions as to the structure and history of the earth, which have excited the attention alike of physicists, geologists, biologists, geographers, and ethnologists. If we imagine an observer contemplating the earth from a convenient distance in space, and scrutinizing its features as it rolls before him, we may suppose him to be struck with the fact that eleven sixteenths of its surface are covered with water, and that the land is so unequally distributed that from one point of view he would see a hemisphere almost exclusively oceanic, while nearly the whole of the dry land is gathered in the opposite hemisphere. He might observe that the great oceanic area of the Pacific and Antarctic Oceans is dotted with islands—like a shallow pool with stones rising above its surface—as if its general depth were small in comparison with its area. He might also notice that a mass or belt of land surrounds each pole, and that the northern ring sends off to the southward three vast tongues of land and of mountain-chains, terminating respectively in South America, South Africa, and Australia, toward which feebler and insular processes are given off by the Antarctic continental mass. This, as some geographers have observed, gives a rudely three-ribbed aspect to the earth, though two of the three ribs are crowded together and form the Europ-Asian mass or double continent, while the third is isolated in the single Continent of America. He might also observe that the northern girdle is cut across, so that the Atlantic opens by a wide space into the Arctic Sea, while the Pacific is contracted toward the north, but confluent with the Antarctic Ocean. The Atlantic is also relatively deeper and less cumbered with islands than the Pacific, which has the higher ridges near its shores, constituting what some visitors to the Pacific coast of America have not inaptly called the "back of the world," while the wider slopes face the narrower ocean, into which for this reason the greater part of the drainage of the land is poured. The Pacific and Atlantic, though both depressions or flattenings of the earth, are, as we shall find, different in age, character, and conditions; and the Atlantic, though the smaller, is the older, and from the geological point of view, in some respects, the more important of the two. If our imaginary observer had the means of knowing anything of the rock formations of the continents,

* From the inaugural address of the President of the British Association for the Advancement of Science, delivered at Birmingham, England, September 1, 1886.

he would notice that those bounding the North Atlantic are in general of great age, some belonging to the Laurentian system. On the other hand, he would see that many of the mountain-ranges along the Pacific are comparatively new, and that modern igneous action occurs in connection with them. Thus he might be led to believe that the Atlantic, though comparatively narrow, is an older feature of the earth's surface, while the Pacific belongs to more modern times. But he would note in connection with this that the oldest rocks of the great continental masses are mostly toward their northern ends, and that the borders of the northern ring of land and certain ridges extending southward from it constitute the most ancient and permanent elevations of the earth's crust, though now greatly surpassed by mountains of more recent age nearer the equator.

Before leaving this general survey we may make one further remark. An observer looking at the earth from without would notice that the margins of the Atlantic and the main lines of direction of its mountain-chains are northeast and southwest, and northwest and southeast, as if some early causes had determined the occurrence of elevations along great circles of the earth's surface tangent to the polar circles. We are invited by the preceding general glance at the surface of the earth to ask certain questions respecting the Atlantic: 1. What has at first determined its position and form? 2. What changes has it experienced in the lapse of geological time? 3. What relations have these changes borne to the development of life on the land and in the water? 4. What is its probable future? Before attempting to answer these questions, which I shall not take up formally in succession, but rather in connection with each other, it is necessary to state as briefly as possible certain general conclusions respecting the interior of the earth. It is popularly supposed that we know nothing of this beyond a superficial crust perhaps averaging fifty thousand to one hundred thousand feet in thickness. It is true we have no means of exploration in the earth's interior, but the conjoined labors of physicists and geologists have now proceeded sufficiently far to throw much inferential light on the subject, and to enable us to make some general affirmations with certainty; and these it is the more necessary to state distinctly, since they are often treated as mere subjects of speculation and fruitless discussion:

1. Since the dawn of geological science, it has been evident that the crust on which we live must be supported on a plastic or partially liquid mass of heated rock, approximately uniform in quality under the whole of its area. This is a legitimate conclusion from the wide distribution of volcanic phenomena, and from the fact that the ejections of volcanoes, while locally of various kinds, are similar in every part of the world. It led to the old idea of a fluid interior of the earth, but this is now generally abandoned, and this interior heated and plastic layer is regarded as merely an under-crust.

2. We have reason to believe, as the result of astronomical investigations, that, notwithstanding the plasticity or liquidity of the under-crust, the mass of the earth—its nucleus, as we may call it—is practically solid, and of great density and hardness. Thus we have the apparent paradox of a solid yet fluid earth ; solid in its astronomical relations, liquid or plastic for the purposes of volcanic action and superficial movements.

3. The plastic sub-crust is not in a state of dry, igneous fusion, but in that condition of aqueo-igneous or hydro-thermic fusion which arises from the action of heat on moist substances, and which may either be regarded as a fusion or as a species of solution at a very high temperature. This we learn from the phenomena of volcanic action, and from the composition of the volcanic and plutonic rocks, as well as from such chemical experiments as those of Daubrée and of Tilden and Shenstone.

4. The interior sub-crust is not perfectly homogeneous, but may be roughly divided into two layers or magmas, as they have been called—an upper, highly siliceous or acidic, of low specific gravity and light-colored, and corresponding to such kinds of plutonic and volcanic rocks as granite and trachyte ; and a lower, less siliceous or more basic, more dense, and more highly charged with iron, and corresponding to such igneous rocks as the dolerites, basalts, and kindred lavas. It is interesting here to note that this conclusion, elaborated by Durocher and Von Waltershausen, and usually connected with their names, appears to have been first announced by John Phillips in his "Geological Manual," and as a mere common-sense deduction from the observed phenomena of volcanic action and the probable results of the gradual cooling of the earth. It receives striking confirmation from the observed succession of acidic and basic volcanic rocks of all geological periods and in all localities. It would even seem, from recent spectroscopic investigations of Lockyer, that there is evidence of a similar succession of magmas in the heavenly bodies, and the discovery by Nordenskiöld of native iron in Greenland basalts affords a probability that the inner magma is in part metallic.

5. Where rents or fissures form in the upper crust, the material of the lower crust is forced upward by the pressure of the less supported portions of the former, giving rise to volcanic phenomena either of an explosive or quiet character, as may be determined by contact with water. The underlying material may also be carried to the surface by the agency of heated water, producing those quiet discharges which Hunt has named crenitic. It is to be observed here that explosive volcanic phenomena and the formation of cones are, as Prestwich has well remarked, characteristic of an old and thickened crust ; quiet ejection from fissures and hydrothermal action may have been more common in earlier periods, and with a thinner over-crust.

6. The contraction of the earth's interior by cooling and by the

emission of material from below the over-crust has caused this crust to press downward, and therefore laterally, and so to effect great bends, folds, and plications; and these, modified subsequently by surface denudation, constitute mountain-chains and continental plateaus. As Hall long ago pointed out, such lines of folding have been produced more especially where thick sediments had been laid down on the sea-bottom. Thus we have here another apparent paradox—namely, that the elevations of the earth's crust occur in the places where the greatest burden of *détritus* has been laid down upon it, and where, consequently, the crust has been softened and depressed. We must beware, in this connection, of exaggerated notions of the extent of contraction and of crumpling required to form mountains. Bonney has well shown, in lectures delivered at the London Institution, that an amount of contraction almost inappreciable in comparison with the diameter of the earth would be sufficient; and that, as the greatest mountain-chains are less than one six-hundredth of the earth's radius in height, they would, on an artificial globe a foot in diameter, be no more important than the slight inequalities that might result from the paper gores overlapping each other at the edges.

7. The crushing and sliding of the over-crust implied in these movements raise some serious questions of a physical character. One of these relates to the rapidity or slowness of such movements, and the consequent degree of intensity of the heat developed, as a possible cause of metamorphism of rocks. Another has reference to the possibility of changes in the equilibrium of the earth itself as resulting from local collapse and ridging. These questions in connection with the present dissociation of the axis of rotation from the magnetic poles, and with changes of climate, have attracted some attention, and probably deserve further consideration on the part of physicists.

In so far as geological evidence is concerned, it would seem that the general association of crumbling with metamorphism indicates a certain rapidity in the process of mountain-making, and consequent development of heat, and the arrangement of the older rocks around the Arctic basin forbids us from assuming any extensive movement of the axis of rotation, though it does not exclude changes to a limited extent. I hope that Professor Darwin will discuss these points in his address to the Physical Section. I wish to formulate these principles as distinctly as possible, and as the result of all the long series of observations, calculations, and discussions since the time of Werner and Hutton, and in which a vast number of able physicists and naturalists have borne a part, because they may be considered as certain deductions from our actual knowledge, and because they lie at the foundation of a rational physical geology.

Keeping in view these general conclusions, let us now turn to their bearing on the origin and history of the North Atlantic. Though the Atlantic is a deep ocean, its basin does not constitute so much a depression of the crust of the earth as a flattening of it; and this, as recent soundings have shown, with a slight ridge or elevation along its middle, and banks or terraces fringing the edges, so that its form is not so much that of a basin as that of a shallow plate with its middle a little raised. Its true, permanent margins are composed of portions of the over-crust folded, ridged up, and crushed as if by lateral pressure emanating from the sea itself. We can not, for example, look at a geological map of America without perceiving that the Appalachian ridges, which intervene between the Atlantic and the St. Lawrence Valley, have been driven bodily back by a force acting from the east, and that they have resisted this pressure only where, as in the Gulf of St. Lawrence and the Catskill region of New York, they have been protected by outlying masses of very old rocks, as, for example, by that of the Island of Newfoundland, and that of the Adirondack Mountains. The admirable work begun by my friend and fellow-student Professor James Nicol, followed up by Hicks, Lapworth, and others, and now, after long controversy, fully confirmed by the recent observations of the geological survey of Scotland, has shown the most intense action of the same kind on the east side of the ocean in the Scottish Highlands; and the more widely distributed Eozoic rocks of Scandinavia may be appealed to in further evidence of this.

If we now inquire as to the cause of the Atlantic depression, we must go back to a time when the areas occupied by the Atlantic and its bounding coasts were parts of a shoreless sea in which the earliest gneisses or stratified granites of the Laurentian age were being laid down in vastly extended beds. These ancient crystalline rocks have been the subject of much discussion and controversy, and, as they constitute the lowest and probably the firmest part of the Atlantic sea-bed, it is necessary to inquire as to their origin and history. Dr. Bonney, the late President of the Geological Society, in his anniversary address, and Dr. Sterry Hunt, in an elaborate paper communicated to the Royal Society of Canada, have ably summed up the hypotheses as to the origin of the oldest Laurentian beds. At the basis of these hypotheses lies the admission that the immensely thick beds of orthoclase gneiss, which are the oldest stratified rocks known to us, are substantially the same in composition with the upper or siliceous magma or layer of the under-crust. They are, in short, its materials either in their primitive condition or merely rearranged. One theory considers them as original products of cooling, owing their lamination merely to the successive stages of the process. Another view refers them to the waste and rearrangement of the materials of a previously massive granite. Still another holds that all our granites really arise from the fusion of old gneisses of originally aqueous origin; while a fourth refers the gneisses themselves to molecular changes effected in granite by pressure.

It will be observed, in regard to these theories, that none of them suppose that the old gneiss is an ordinary sediment, but that all regard it as formed in exceptional circumstances, these circumstances being the absence of land and of sub-aërial decay of rock, and the presence wholly or principally of the material of the upper surface of the recently hardened crust. This being granted, the question arises, Ought we not to combine these several theories and to believe that the cooling crust has hardened in successive layers from without inward; that at the same time fissures were locally discharging igneous matter to the surface; that matter held in suspension in the ocean, and matter held in solution by heated waters rising from beneath the outer crust, were mingling their materials in the deposits of the primitive ocean? It would seem that the combination of all these agencies may safely be invoked as causes of the pre-Atlantic deposits. This is the eclectic position which I endeavored to maintain in my address before the Minneapolis meeting of the American Association in 1883, and which I still hold to be in every way probable. That these old gneisses were deposited not only in what is now the bed of the Atlantic, but also on the great continental areas of America and Europe, any one who considers the wide extent of these rocks represented on the map recently published by Professor Hull can readily understand.

It is true that Hull supposes that the basin of the Atlantic itself may have been land at this time, but there is no evidence of this, more especially as the material of the gneiss could not have been *détritus* derived from sub-aërial decay of rock. Let us suppose, then, the floor of Old Ocean covered with a flat pavement of gneiss, or of that material which is now gneiss, the next question is, How and when did this original bed become converted into sea and land? Here we have some things certain, others most debatable. That the cooling mass, especially if it were sending out volumes of softened rocky material, either in the exo-plutonic or in the crenitic way, and piling this on the surface, must soon become too small for its shell, is apparent; but when and where would the collapse, crushing, and wrinkling inevitable from this cause begin? Where they did begin is indicated by the lines of mountain-chains which traverse the Laurentian districts; but the reason why is less apparent. The more or less unequal cooling, hardening, and conductive power of the outer crust we may readily assume. The driftage unequally of water-borne *détritus* to the southwest by the bottom-currents of the sea is another cause, and, as we shall soon see, most effective. Still another is the greater cooling and hardening of the crust in the polar regions, and the tendency to collapse of the equatorial protuberance from the slackening of the earth's rotation. Besides these, the internal tides of the earth's substance at the times of solstice would exert an oblique pulling force on the crust, which might tend to crack it along diagonal lines.

From whichever of these causes, or the combination of the whole, we know that within the Laurentian time folded portions of the earth's crust began to rise above the general surface in broad belts running from northeast to southwest, and from northwest to southeast, where the older mountains of Eastern America and Western Europe now stand, and that the subsidence of the oceanic areas allowed by this crumbling of the crust permitted other areas on both sides of what is now the Atlantic to form limited table-lands. This was the beginning of a process repeated again and again in subsequent times, and which began in the Middle Laurentian, when for the first time we find beds of quartzite, limestone, and iron-ore, and graphitic beds, indicating that there were already land and water, and that the sea, and perhaps the land, swarmed with animal and plant life, of forms unknown to us, for the most part, now.

Independently of the questions as to the animal nature of Eozoön, I hold that we know, as certainly as we can know anything inferentially, the existence of these primitive forms of life. If I were to conjecture what were the early forms of plant and animal life, I would suppose that just as in the Palæozoic the acrogens culminated in gigantic and complex forest-trees, so in the Laurentian the algæ, the lichens, and the mosses grew to dimensions and assumed complexity of structure unexampled in later times, and that in the sea the humbler forms of Protozoa and Hydrozoa were the dominant types, but in gigantic and complex forms. The land of this period was probably limited, for the most part, to high latitudes, and its aspect, though more rugged and abrupt, and of greater elevation, must have been of that character which we still see in the Laurentian hills. The distribution of this ancient land is indicated by the long lines of old Laurentian rock extending from the Labrador coast and the north shore of the St. Lawrence, and along the eastern slopes of the Appalachians in America, and the like rocks of the Hebrides, the Western Highlands, and the Scandinavian mountains. A small but interesting remnant is that in the Malvern Hills, so well described by Holl.

It will be well to note here and to fix on our minds that these ancient ridges of Eastern America and Western Europe have been greatly denuded and wasted since Laurentian times, and that it is along their eastern sides that the greatest sedimentary accumulations have been deposited. From this time dates the introduction of that dominance of existing causes which forms the basis of uniformitarianism in geology, and which had to go on with various and great modifications of detail through the successive stages of the geological history till the land and water of the northern hemisphere attained to their present complex structure. So soon as we have a circumpolar belt or patches of Eozoic land and ridges running southward from it, we enter on new and more complicated methods of growth of the continents and seas. Here we are indebted to Le Conte for clearly pointing out that our original

Eozoic tracts of continent were in the earliest times areas of deposition, and that the first elevations of land out of the primeval ocean must have differed in important points from all that have succeeded them; but they were equally amenable to the ordinary laws of denudation. Portions of these oldest crystalline rocks, raised out of the protecting water, were now eroded by atmospheric agents, and especially by the carbonic acid then existing in the atmosphere, perhaps more abundantly than at present, under whose influence the hardest of the gneissic rocks gradually decay. The Arctic lands were subjected, in addition, to the powerful mechanical force of frost and thaw. Thus every shower of rain and every swollen stream would carry into the sea the products of the waste of land, sorting them into fine clays and coarser sands; and the cold currents which cling to the ocean-bottom, now determined in their courses, not merely by the earth's rotation, but also by the lines of folding on both sides of the Atlantic, would carry southwestward, and pile up in marginal banks of great thickness, the *débris* produced from the rapid waste of the land already existing in the Arctic regions. The Atlantic, opening widely to the north, and having large rivers pouring into it, was especially the ocean characterized, as time advanced, by the prevalence of these phenomena.

Thus throughout the geological history it has happened that, while the middle of the Atlantic has received merely organic deposits of shells of Foraminifera and similar organisms, and this probably only to a small amount, its margins have had piled upon them beds of *détritus* of immense thickness. Professor Hall, of Albany, was the first geologist who pointed out the vast cosmic importance of these deposits, and that the mountains of both sides of the Atlantic owe their origin to these great lines of deposition; along with the fact, afterward more fully insisted upon by Rogers, that the portions of the crust which received these masses of *débris* became thereby weighted down and softened, and were more liable than other parts to lateral crushing. Thus in the later Eozoic and early Palæozoic times, which succeeded the first foldings of the oldest Laurentian, great ridges were thrown up, along the edges of which were beds of limestone, and on their summits and sides thick masses of ejected igneous rocks. In the bed of the central Atlantic there are no such accumulations. It must have been a flat, or slightly ridged, plate of the ancient gneiss, hard and resisting, though perhaps with a few cracks, through which igneous matter welled up, as in Iceland and the Azores in more modern times. In this condition of things we have causes tending to perpetuate and extend the distinctions of ocean and continent, mountain and plain, already begun; and of these we may more especially note the continued subsidence of the areas of greatest marine deposition. This has long attracted attention, and affords very convincing evidence of the connection of sedimentary deposit as a cause with the subsidence of the crust.

We are indebted to a French physicist, M. Faye, for an important suggestion on this subject. It is that the sediment accumulated along the shores of the ocean presented an obstacle to radiation, and consequently to cooling of the crust, while the ocean-floor, unprotected and unweighted, and constantly bathed with currents of cold water, having great power of convection of heat, would be more rapidly cooled, and so would become thicker and stronger. This suggestion is complementary to the theory of Professor Hall, that the areas of greatest deposit on the margins of the ocean are necessarily those of greatest folding and consequent elevation. We have thus a hard, thick, resisting ocean-bottom which, as it settles down toward the interior, under the influence of gravity, squeezes upward and folds and plicates all the soft sediments deposited on its edges. The Atlantic area is almost an unbroken cake of this kind. The Pacific area has cracked in many places, allowing the interior fluid matter to ooze out in volcanic ejections. It may be said that all this supposes a permanent continuance of the ocean-basins, whereas many geologists postulate a mid-Atlantic continent to give the thick masses of *détritus* found in the older formations both in Eastern America and Western Europe, and which thin off in proceeding into the interior of both continents. I prefer, with Hall, to consider these belts of sediments as in the main the deposits of northern currents, and derived from Arctic land, and that, like the great banks of the American coast at the present day, which are being built up by the present Arctic current, they had little to do with any direct drainage from the adjacent shore. We need not deny, however, that such ridges of land as existed along the Atlantic margins were contributing their quota of river-borne material, just as on a still greater scale the Amazon and Mississippi are doing now, and this especially on the sides toward the present continental plateaus, though the greater part must have been derived from the wide tracts of Laurentian land within the Arctic Circle or near to it.

It is further obvious that the ordinary reasoning respecting the necessity of continental areas in the present ocean-basins would actually oblige us to suppose that the whole of the oceans and continents had repeatedly changed places. This consideration opposes enormous physical difficulties to any theory of alternations of the oceanic and continental areas, except locally at their margins. I would, however, refer you for a more full discussion of these points to the address to be delivered to-morrow by the President of the Geological Section. But the permanence of the Atlantic depression does not exclude the idea of successive submergences of the continental plateaus and marginal slopes, alternating with periods of elevation, when the ocean retreated from the continents and contracted its limits. In this respect the Atlantic of to-day is much smaller than it was in those times when it spread widely over the continental plains and slopes, and much larger than it has been in times of continental elevation. This leads us to the further consideration that, while the ocean-beds have been sinking, other areas have been better supported, and constitute the continental plateaus; and that it has been at or near the junctions of these sinking and rising areas that the thickest deposits of *détritus*, the most extensive foldings, and the greatest ejections of volcanic matter have occurred.

There has thus been a permanence of the position of the continents and oceans throughout geological time, but with many oscillations of these areas, producing submergences and emergences of the land. In this way we can reconcile the vast vicissitudes of the continental areas in different geological periods with that continuity of development from north to south and from the interiors to the margins, which is so marked a feature. We have for this reason to formulate another apparent geological paradox—namely, that while in one sense the continental and oceanic areas are permanent, in another they have been in continual movement. Nor does this view exclude extension of the continental borders or of chains of islands beyond their present limits at certain periods; and, indeed, the general principle already stated, that subsidence of the ocean-bed has produced elevation of the land, implies in earlier periods a shallower ocean and many possibilities as to volcanic islands and low continental margins creeping out into the sea; while it is also to be noted that there are, as already stated, bordering shelves, constituting shallows in the ocean, which at certain periods have emerged as land.

We are thus compelled to believe in the contemporaneous existence in all geological periods, except perhaps the earliest of them, of three distinct conditions of areas on the surface of the earth:

1. Oceanic areas of deep sea, which always continued to occupy in whole or in part the bed of the present ocean.

2. Continental plateaus and marginal shelves, existing as low flats or higher table-lands, liable to periodical submergence and emergence.

3. Lines of plication and folding, more especially along the borders of the oceans, forming elevated portions of land, rarely altogether submerged, and constantly affording the material of sedimentary accumulations, while they were also the seats of powerful volcanic ejections.

In the successive geological periods the continental plateaus when submerged, owing to their vast extent of warm and shallow sea, have been the great theatres of the development of marine life and of the deposition of organic limestones, and when elevated they have furnished the abodes of the noblest land faunas and floras. The mountain-belts, especially in the north, have been the refuge and stronghold of land life in periods of submergence, and the deep ocean-basins have been the perennial abodes of pelagic and abyssal creatures, and the refuge of multitudes of other marine animals and plants in times of continental elevation.

These general facts are full of importance with reference to the question of the succession of formations and of life in the geological history of the earth. So much time has been occupied with these general views that it would be impossible to trace the history of the Atlantic in detail through the ages of the Palæozoic, Mesozoic, and Tertiary. We may, however, shortly glance at the changes of the three kinds of surface already referred to.

The bed of the ocean seems to have remained, on the whole, abyssal, but there were probably periods when those shallow reaches of the Atlantic, which stretch across its most northern portion and partly separate it from the Arctic basin, presented connecting coasts or continuous chains of islands sufficient to permit animals and plants to pass over. At certain periods also there were not unlikely groups of volcanic islands, like the Azores, in the temperate or tropical Atlantic. More especially might this be the case in that early time when it was more like the present Pacific; and the line of the great volcanic belt of the Mediterranean, the mid-Atlantic banks, the Azores, and the West India islands point to the possibility of such partial connections. These were stepping-stones, so to speak, over which land organisms might cross, and some of these may be connected with the fabulous or prehistoric Atlantis.

[*To be continued.*]

SOME OUTLINES FROM THE HISTORY OF EDUCATION.

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III.

THE truths of the educational reformers reached comparatively small circles. Everywhere the schools continued to turn out ministers and priests; indeed, this was the accepted design of the schools. We have many illustrations of the home training during these years. I name a few as recorded. Christian Weise, eight years of age, was required by his parents to discontinue study on account of sickness. He objected to this course, saying "The power of Jesus Christ will come to my aid, he who is strong in the sick ones." George Nitzsch (who wrote a treatise entitled "Is Scripture God Himself?") in his ninth year could find no more delightful occupation than prayer and memorizing sermons. Feustking, when he was nine years old, had read the Bible through five times, and at the same age had preached before his father's congregation. It is said that some one wished to use extracts from classical writers; the Church authorities thereupon decided that the New Testament was written in the purest Attic Greek, and that any change was unnecessary.

We meet now a most instructive manifestation in the history of education. Formalism was blighting the Church, whether Catholic or Protestant; and blighting education, whether Jesuit or Lutheran. This formalism encountered an entirely new opposition, and all educational movement received a most peculiar shaping. Spirituality is the grace and life of some souls, as it is not the grace and life of some other souls. Never a church or party so bad as to contain no spiritually-minded. These are they who now appear, materially affecting the course and method of education. We should see clearly the position of affairs. Speaking historically, there are two oppositions to scholastic orthodoxy in education: one, the realistic, basing itself upon an experimental philosophy, and eventually working itself out as a scientific method; the other, spiritualistic, basing itself upon the purely spiritual elements of our nature, and developing into mysticism, pietism, and all vagary. There is a singularly interesting comparison between these different attacks upon scholastic orthodoxy. We have seen how the experimental philosophy received form and power from Bacon; we have seen how Comenius applied this philosophy to education; yet we know that education was not rescued from scholasticism. The reason, as I believe, lies in this fact: A purely or even a largely intellectual opposition was not able to reach the emotions and the conscience, and, until these were profoundly stirred, there would be no true, permanent deliverance from scholastic orthodoxy. A protest must arise from the side of the feeling. Precisely this did arise, precisely such an opposition manifested itself within both churches, appearing as Jansenism with the Catholics and pietism with the Protestants. This emotional protest, this protest in the Church herself against herself, brought clearly to view the radical antagonism between scholastic training and the newer methods everywhere appearing.

Jansen, born 1585 in North Holland, found the fundamental evil of his time to consist in the exclusive occupation of men with heathen philosophy—i. e., with Aristotelian scholastic. He made a thorough separation between philosophy and theology, believing them to rest upon widely different bases. This Jansenist movement in the Catholic Church was applied to education by the society at Port Royal. The most celebrated representatives of the method are Rollin and Fénelon. A sentence or two from Rollin will show his position: "I know that the true purpose of the teacher is not merely to make the scholars acquainted with Greek and Latin, or to teach them to write verses and exercises, or to burden their memory with events and dates from history, or to enable them to shape their conclusions in correct form, or to draw lines and figures upon paper. I do not deny that these studies are useful and worthy all praise, but only as means not as end, only when they serve as preparations to better things." Rollin is plainly a humanist. In his opinion a study of the languages is most important as an introduction to all knowledge. As respects the methods of learning these languages Rollin directly opposes scholasticism and appeals to Nature. He is right in this, for, if Latin and Greek are to be taught at all, they are to be taught *naturally;* and if those who advocate classical training as an essential part of every student's education would do *permanent* work for their conviction, let them present these languages *naturally* and *philosophically*. The opposition to formalism based upon the spiritual nature was universal, and produced similar results in many lands. It was known among the Catholics as Jansenism in the Netherlands and France, as Quietism in Italy and Spain. It was known among the Protestants as Mysticism and Pietism in Germany. The Protestant German representatives of this reaction are Böhm, Spener, and Zinzendorf. A few lines from the first of these men show the nature of mysticism and its relation to education. Böhm writes: "Man is the image, life, and being, of the uncaused God. In man's body is all Nature concentrated. The soul is the outspoken word, as the power and understanding of all being, as the revelation of Divine Reason. Man stands in the outward world and bears in himself heaven and hell. As the spirit of eternity has imaged all things, so the human spirit bodies itself forth in word, for everything originates from one center. If I read myself, I read God's book. We know Nature, because we stand in her and have her in ourselves. We know God, because he is in us and we live in him. God himself is our seeing and knowing—from God's seeing has sprung my seeing."

Such thorough-going opinion would not tolerate the faults of a dead and formal training. Böhm saw the error from his point of view, and hesitated not to speak: "The small boy who runs about in play is full of the poison and iniquity of the devil, and all forms of vice inhere in him. He is a mocker, a swearer, thoroughly prepared to serve the devil in all his deeds. The shamelessness is the Latin on his tongue. He knows how to imitate all the jesting words of the ancients. The youth mock without consideration. Whoso fears God must be their fool and jest. Their parents see these youth, and rejoice that the boys are so skillful in their rascality." Mysticism, Quietism, Pietism, are differing names for one and the same protest made by the spirit against the letter. Since there never was a time in the history of Protestantism when so direct an attempt was made to conduct education according to the religious spirit, it may be wise to give this matter more thorough consideration. Pietism may be said to have been established by Philip Jacob Spener, born at Rappoltsweiler in Elsass, 1635. We shall, as I think, best recognize his spirit and method by the following sentences from his writings: "Before all things we should hold fast the fundamental truth that Christianity does not show itself in *knowledge* but in *practice*, and that the Christians must be led to works of unselfish love, to the control of their spirits under slander, to the withholding of themselves from all revenge, to love and patience even in theological matters. Our fathers, with praiseworthy anxiety, established schools; they did so that, in these schools, the youth might not simply be built up to manhood, but especially that they might be led by pious training to a living knowledge of their Father; that the image of God might be more and more perfected in them, that from these schools men should go forth, not simply for the spread of knowledge, but that, equipped with every virtue which leads to true happiness, they might serve the honor of God and the public good in the position to which God had appointed them. As it now is, all industry in the schools is given to Latium, so that little remains for Hellas, for Judea scarcely anything. Our youth go from the schools tolerably well furnished with such knowledge as they shall put to outward use, but without knowing God, all absorbed in love for the world and endeavor to please it, wise for themselves, but so much the less instructed in divine wisdom."

We must clearly know what pietism, at its best estate, proposed as the end of education. We shall, I think, find this end distinctly set forth in the following utterances:

"The final purpose of all education is a living recognition of God and an upright Christian deportment. Only the genuinely pious man is a good citizen of society. Without true piety, all knowledge, all skill, all world-culture, are more harmful than useful, and man is never safe from the misuse of knowledge. First, and before all other things, education must strive for the radical improvement of the heart. Everything which immediately or mediately works against this supreme and final end must be banished. *Instruction is subordinated to training.*" (Italics the present writer's.) "The purpose of the school is not an impartation of certain knowledges—*all* teaching must contain an *educative* tendency. The design of such training is the upbuilding of the kingdom of God in the heart of the child, and, proceeding from this basis, education should be comprehended in all its grades and divisions as one system, one culture. Those who give themselves to study should regard the ancient languages as the chief concern. Latin is to be pursued the most, and grammatically, from the beginning. Greek has its basis in the New Testament. A chief advantage to be gained from the ancient languages is a right understanding of the sacred Scriptures, which every student should read in the original. It is well to understand the heathen writers; still, too much occupation with them easily leads away from a high estimation of the Bible. Next to the languages, no student should remain unacquainted with geography, mathematics, history, astronomy, and natural philosophy. In the higher classes logic, which leads to orderly thought, and rhetoric, which leads to correct and good expression, should be pursued and made practical by exercises and disputations."

Referring, again, to the spirit in which education should be conducted, Spener asks: "To what does all the striving of the professors tend but to fill out the brain with theological philosophy, or a human skill in holy things, while their hearts are void of all true heavenly influences? The anxiety of the far-seeing Erasmus is but too fully realized, for he testified that his joy over the widely increasing application to study was diminished by the fear that much heathenism would steal in upon the spirit."

With the general endeavor expressed in these words a large proportion of educators from all sects and parties would agree. That education should strive for the radical improvement of the heart, that the purpose of the school as such, i. e., from first to last, is not merely the impartation of certain knowledges, that all teaching must contain an *educative* tendency—these are propositions which commend themselves to all who have had direct relations with the young in their years of development. It is well known, however, that many are honestly disposed to go much further than this. It is the conviction of a large number of our people that education must never be allowed to become godless; that each institution of learning should make it an essential part of its business to inculcate the fundamentals of religion. It is the reiterated assertion of one of the most powerful church organizations to be found in history, that our schools are without God, and so permit the young of both sexes to grow up uninstructed in the essential truths of a right life. The history of education teaches some plain and weighty lessons respecting this present matter. The pietistic movement originated naturally and justly. It was the full protest of the spiritual nature against formalism. It recognized something better than knowledge, and it sought to furnish this higher truth. Its position was exactly that of many sincere minds to-day who feel dissatisfied with the education of any young man or woman that consists of knowledge alone, being without the informing spirit that leads to nobility of character.

What did pietism accomplish? *It brought the schools back to every-day life.* Applying catechetical instruction to the children, and regarding all education as designed to nourish a spirit of piety, these protestants against formalism drew education out into general view and common life. The schools were regarded as an organic whole, whose basis was the common school; and, further, the entire school system was placed in most intimate relations with the home — the school-training being required to be supplemented by home-culture. These principles spread over Protestant Germany; schools for the poor and orphan-schools were established in great number. We ask what came from this attempt to conduct education in the religious spirit? Our answer is, a most lamentable extreme—a serious and thorough failure. As if in very mockery, the protestants against formalism became diseased with formality. Pietism became the letter that killeth. Here was the principle which worked all mischief. Let man keep himself from everything not avowedly and directly religious. The application of this principle separated man more and more from real life, and, in the place of that very spirit to be brought out and cherished, there was left to these schools of the pietists a vicious form. The outward posture became the essential thing. A spiritual police system was introduced, all schools and families were constantly searched in quest of the chief means of instruction—the Bible and the catechism. It came to be believed that the young people, if left to themselves, would go to destruction. Accordingly, the pupils were never left alone, not even for a moment; exercises for worship were multiplied, praying and preaching never ceased. Here was an educational system originated to develop true piety, and actually producing lying, hypocrisy, and contemptible Phariseeism. Here was an educational system designed in the interests of spirituality, and at the same time working a twofold evil—crushing out in weaker natures all fresh, individual life-power; repressing in stronger natures those passions which fed upon themselves for the years of school-life only to break forth at last with destructive fury.

We may realize the fearful state to which pietism came by noting the condition of the orphan-schools and poor-schools. These houses were originally the result of Christian sympathy; they became "instruments for a kind of soul-cure." The prayers of the orphans were solicited and published on the doors of the buildings. "Four groschen to pray for a man with bad eyes." "One groschen to be freed from the toothache." "Eight groschen, pray God, dear orphans, on account of my sinful thoughts." "Four groschen that God may send me belief on the Son of God." Spener did not recognize the truth he proclaimed—he was never entirely free from the formalism he opposed. He felt the deadness of the Church, and at the same time believed that salvation was necessarily bound up with certain forms of dogmatical teaching. He desired a true and living piety, but did not believe this was anywise possible except for those who accepted, without question, the visible, literal form of faith. Piety, thus confined, could not develop otherwise than as it did with Spener and his associates. This striking movement in the history of education and its disastrous outcome might well lead the thoughtful mind to inquire whether religion is a matter that can be taught. It may lie in the very nature of this subject that it can not be communicated from the professorial chair, however wonderfully endowed. Upon the supposition (an hypothesis far beyond the territory of hope) that all educators could agree as to what make up the fundamentals of religion, it might be found that the best, the *only*, method of imparting them would be *by example*, by a deportment sincerely in harmony with them.*

* See, in this connection, that delightful little work, "An Attic Philosopher," by Émile Souvestre.

Reference has been made in these papers to a third general cause contributing to the rescue of education from middle-age formalism. This third cause was "discovery," that is, actual increase of knowledge in various domains. This enlarged knowledge was, for the most part, of a physical character; it had reference to the visible, measurable phenomena of Nature. There lay wrapped up in the wonderful advancements of the eighteenth century both bane and blessing. Society, as representing the external relations of men with one another, was immeasurably benefited. Civilization, as we now know it, received power to become only through the magnificent discernment of natural laws which, beginning in the earlier part of the eighteenth century, has proceeded with sure course to our own time. Health and wealth and all physical comforts were secured for men as never before by manifold scientific discoveries. We should go even further than this and recognize the relation which obtains between man's physical and his intellectual and moral well-being. To increase man's healthfulness is to make possible an increase in his intellectual and moral nature. An almost immeasurable amount of ignorance and vice must be attributed to bodily disease and untoward physical surroundings. To purify the air which man breathes and the food which he eats is to take the first steps for his culture and his salvation. All gratitude, then, for the work which has been done, and is now doing, to improve man's physical condition! Such work is organically connected with whatsoever is truly progressive in intellect, morality, and religion.

I have said that there was evil in the course of this movement in the eighteenth century which we are now considering. *Denial, or rather that doubtful mind which is essential to the attainment of truth, became an end and afforded pleasure.* No evil that can befall man is greater than the evil of *loving to deny.* This evil began its course in English deism, went on to fuller manifestation in the admirers of Voltaire, and found its completion in D'Holbach and Büchner. Let not this statement be misunderstood. Men are sick, and know not the disease which afflicts them. Disease is often concealed in its development along the line of generations. The father appears rational and well, the poisoned child becomes demented and dies. History is, as it were, the life of one man prolonged; whatsoever lies in this life finds time for development and full manifestation. English deism was an expression of the critical spirit in England. Whence did this spirit receive its peculiar power? From the deaths of persecuted seekers after truth. Here and there a man searched till he found. When he spoke, they slew him in the name of God and the Church. The age of discovery was come, and the instrument for the work was none other than this same critical spirit, the spirit which would test, which would inquire of Nature until she answered. Who should restrain this spirit, or withhold its manifold applications? When Tyndale and Shaftesbury, applying it to religion, resolved all creeds into one formula of five short phrases, who should hinder? When D'Holbach, in France, and Büchner, in Germany, applying the same spirit to the supposed elementary principles of intellect and morality, resolved these also into movements among the brain-particles, who should hinder? No one should hinder either deism or materialism, if it but leads to the truth, to the real. What shall we say if the instrument come to be loved more than the truth it was designed to make known? What if denial become precious *for its own sake?* Here is calamity enough. Here is the extreme;—from credulity to incredulity—from omnivorous belief to omnivorous denial. That there lay in the eighteenth-century development both English deism and French sensualism is no more to constitute a final condemnation of scientific discovery than the monstrosities done in religion's name should be alowed to sweep away the beauties of a pure faith. When one concludes from inquisitions and witch-burnings that there is only evil in Christianity, it is as though he should deny all worth to science because of the critical spirit and its monstrosity, a *love of denial.*

English deism was applied to education in Defoe's remarkable book "Robinson Crusoe." Man is to be educated *according to Nature,* rather should we say *by* Nature.

The contrast is sharp between the natural method of Comenius and this new appeal to Nature. Here society, school-systems, books, were to have no place. To Nature, as a sort of divine person, the child was surrendered for education. It was supposed that Nature would bring out the universal traits of mind, the universal religious ideas, the universal social laws. We find here a most instructive illustration of the tendency, so universal in human thinking, to personify our abstractions. Words such as nature, justice, virtue, law, are used by us to represent some independent entity or being. This ineradicable habit has been the source of desperate evils in all directions. We have now before us its application in education. We are told to follow Nature. This Nature, be it understood, is an all-wise being, independent of our activities, able to guide us with a perfect wisdom. Such was the phase through which education must pass before the true method of following Nature could appear. The sharply contrasted lines of training, now known as the scientific and the classical, are being differentiated at the time of which we write. More than this, if we look closely we shall find here a reason in history for regarding the scientific training as pre-eminently natural, as pre eminently obedient to the command "Follow Nature."

The critical spirit, applied to education, received brilliant expression in France and serious testing in Germany. I state some of the fundamental principles of Rousseau's "Émile": "Everything is good as it proceeds from the hand of the Creator, everything deteriorates in the hands of man. We are educated by Nature, by men, by things. The child should be educated for a common human calling, not for a special position. No mother, no child. Follow Nature. All the mischief of children comes from weakness; make the child strong, and it will be good. Educators render children miserable in that they take the presence of childhood for nothing, and keep in their eye only the future of the child which it may never reach. See in the child only the child. Before the child reaches understanding, it must be thrown entirely upon the physical world. Therefore, you should not begin to reason too early with children. The first education should be purely negative: it consists not in teaching distinctions between virtue and vice, but in keeping the heart from faults, the understanding from errors. The only moral instruction for children is to do nobody any evil. Instruction should begin with things. At twelve years of age sense-impressions should be built up to conceptions. No other book should be used than the world, no other instruction than facts. The secret of education is so to arrange it that bodily and spiritual exercises are reciprocally helpful. At the fifteenth year of his life Émile appears in this wise cultivated. Obliged to learn by himself, he uses his own, not another man's understanding, and he puts forth nothing on authority. Émile has, to be sure, little but no half knowledge. He knows there is much he does not know. He has only knowledge of Nature—nothing historical; about metaphysics and morality he knows nothing. What death is, he knows not; but accustomed, without resistance, to surrender himself to the law of necessity, he will die, when he must, without a sigh. His body is sound, his limbs are sure, his understanding right and without prejudice, his heart free and without passions. Thus is Émile at fifteen years of age.

"But man is not created to remain a child. He steps out of this condition at Nature's appointed time. His physiognomy changes and gains expression. The voice changes. The eyes, those mirrors of the soul, that hitherto have said nothing, receive language and meaning; an increasing fire animates them, their glances are living. He feels without knowing what he feels. He is restless without cause. Be upon thy guard. Not one moment from the rudder, or all is lost! Now is the man really born to life, and nothing human is foreign to him. Hitherto our anxiety has been but a child's play; now it begins to be a great weight. This time, when generally education is ended, is the very time when ours shall truly commence. Now Émile is to become acquainted with his own kind. This is the period for history. To know men, you must see them act. In intercourse with the world you only hear men speak—they show their words, but conceal their deeds. In history they are unveiled, and we are able to judge. But Émile shall judge them himself—only thus can he gather knowledge of mankind. If the author's opinion continually lead him, he sees through another's glass, and when this fails he sees nothing at all. He shall see with his own eyes, feel with his own heart; no authority shall control him save the authority of his reason. But now he must be led into the world of religion. Brought up as he has been by the sense-world, the abstract scarcely finds entrance. God withdraws himself from our senses. The word Spirit has meaning only for the philosophers. In his fifteenth year Émile does not know whether he has a soul or not. If I wished to represent stupidity symbolically, I would paint a pedant teaching children out of a catechism. They say a child should be reared in the religion of his father, and prove this is the only true one, the others absurd. But suppose the strength of the argument depends upon the district where they use it, or upon authority, to which Émile pays no attention. How then? In what religion shall we educate him? The answer is plain —in none. We will place him in condition to choose that which the best use of his reason may approve."

The time, the thought, and the style of Rousseau's "Émile" combined to make it the most powerful word yet spoken for the true development of education. "It was a vigorous blow against the science of mere words, against the pitiable omniscience of children, against books as means of instruction. Never before had the natural methods for education been so forcibly thrust into the places of the miserable middle-age apparatus."

We need not delay for any extended criticism of Rousseau's thought. Its radical deficiency has been often stated and acknowledged. We phrased it as the personification of an abstraction. Believing in the total degeneration of humanity, believing that there was nothing natural in the historic development, Rousseau would call men back to Nature. How back to Nature? *Where was Nature?* Not in society—in Rousseau? Certainly here, if anywhere, and with this the entire thought fails, so far as respects its efficiency for a scientific principle in education. Émile, separated from his unnatural fellow-beings, must be guarded against the possibility of doing as they did; and yet he must be taught *according to Nature.* Rousseau was all the nature Émile could have, and he would be educated naturally, therefore, only so far as Rousseau corresponded to Nature.

To break away from artificial restraints and to find Nature has fascinated men from earliest times. One of the most beautiful illustrations of this impossible undertaking is the Arabian romance, "Hai Ebn Yokdahn" ("The Nature-Man"). This was written by Tophail, who died in the year 1190, and is mentioned here merely as a reference for those specially interested in these endeavors.

It is among the Germans that we find a serious attempt to apply the new ideas to the actual work of instruction. The philanthropists attempted to realize the educational ideas of Rousseau. Their leading principles, both negative and positive, are as follows: "The universal condition of the world is infinitely bad. Church and state, school and family, are marked by folly and wickedness. Above all, the school is thoroughly defective in its very foundation. Everywhere uncomprehended words are learned *verbatim*, school-dust lies hundreds of years thick on the natural method of teaching languages; every one who breathes this dust is sick in the brain. Instruction carries everywhere the marks of the time when the schools were established. Young people are taught a multitude of things of which they make no use in all their life.

"A *new foundation* must be laid upon which a new species can develop, since a regeneration can not be thought of while the youth are not transplanted to a new ground."

We note a few of the affirmative propositions: "Artists must be trained if art is to prosper. In physical education we must return to the method of the ancients.

"The will must be governed by the reason. During youth religion shall be taught only in its extreme simplicity, without attention to sects or parties. We should not repress the natural tendency to freedom, but guide it. Children are by nature good—compulsion renders them bad.

"The boy who has no sense for anything abstract and incomprehensible, least of all for the ordinary catechism, should, before anything else, be made acquainted with the sense-world. This can be shown to him in Nature and by pictures.

"The youth are troubled with nothing so much as with Latin. More than five years are given simply to the learning of Latin. Yet there is not a fourth of the pupils thus taught who can read Latin books without trouble or without mistakes. When these hindrances are removed, the true aim of education will be reached. This aim is to form Europeans, people having such habits and manners as are common in all Europe, people whose life should be free from harmfulness, as universally useful and contented as they might become through education."

Kant, born April 22, 1724, expressed his opinion very forcibly as to the needs of the schools at this time: "In the civilized lands of Europe educational institutions are not lacking, neither is there lacking, on the part of the teachers, a well-intentioned industry. Still, it has been clearly shown that these institutions are worthless, and that, since *everything in them works contrary to Nature*, they fall far short of bringing out of men the good for which Nature has given the material. We should see quite different men around us if those educational methods came into force which are really drawn out of Nature, and not those which are but slavish imitations of the ancient customs of rude and inexperienced ages. The solicitude of the common people of all lands should now be directed to the establishment of such a master-school. This institution is no longer a merely beautiful idea, but now shows, by visible proofs, the practicability of what has been so long desired. The public repute, and pre-eminently the united voices of scientific and discerning judges from varied lands, have marked the Dessau Educational Institute as the one that displays the evidences of excellence."

Kant's commendatory words refer to the School of the Philanthropists, founded December 27, 1774, at Dessau, under the direction of Basedow. This reformer represented Comenius and Rousseau. A few sentences from his writings are significant in this connection :

"The great aim of education should be to prepare the youth for a *useful, patriotic, and happy life.* Instruction should be rendered as agreeable as is consistent with its nature. Practice in the memory of *things* is far more important than in the memory of *words.*

"But this knowledge of things must furnish new representations to the understanding ; must not simply fill out the memory with words. Paintings and engravings are of great service in instruction. Experience teaches how everything which resembles a picture pleases children."

A public examination of Basedow's work was held in May, 1776. The reformer's invitation contained the following passage : "This affair is not Catholic, Lutheran, or Reformed, but Christian. We are philanthropists, cosmopolitans. Russia's or Denmark's sovereignty is not, in our teachings, placed after Switzerland's freedom. Our text-books are free from theological bias for the Christian as against Jews, Mohammedans, deists, or the dissenters, called, in some places, heretics. Very little memorizing is done by us. The students are not forced to be industrious. Still, we promise by the excellence of our method of instruction, and by its agreement with all philanthropic education, twofold as much progress as can be secured by the best schools or gymnasia." The public examination was favorable, and many influential men approved the undertaking in highest terms. There were bitter enemies, however. Most of the directors of the gymnasia opposed Basedow to the utmost, and Herder expressed a feeling more or less prevalent when he wrote : "The whole thing appears to me horrible. They tell of a new method for raising oak-forests in ten years. I wouldn't give Basedow calves to raise, much less men ! "

We have considered a slow and complex movement, yet one steadily tending to definite result. The movement has been away from classical training as a *necessary part of education.* Montaigne, Bacon, Ratich, Comenius, the pietists, the philanthropists, have led education into new courses. The tendency was clearly revealed in the Dessau Institute. Education has been emancipated from scholasticism, and this with such force as to threaten the future supremacy of Greece and Rome.

As matter of fact, we have now before us, in the historical development of our subject, two sharply contrasted ideas. Whether these ideas are necessarily antagonistic is not the present question. We are concerned with the forces actually at work, and with the manner of their unfolding. Those who favor and those who oppose classical study as a *necessary* part of education can justify their position by an appeal to one or the other of the ideas about to be stated. All questions as to disciplinary benefit, as to method of instruction, as to amount of net result, are wholly out of date. The changes could be rung forever on these matters, with no gain and much loss of temper. Most of the claims put forth by those who advocate the superiority of classical studies are either nonsense or beside the mark. Classical studies *have* advantages—that is to say, excellences—*peculiar to themselves. So have the sciences.* These different advantages will appeal to different minds, and no power can prevent the appeal. Let each party so teach as to bring out the advantages *best*, in fullest manner. If the history of education shows anything, it shows that the place for *all* efficient reform in education is in the *manner* of teaching rather than the *matter*. Devising something new to be learned will never save the soul; devising, or rather finding, the right *way* to impart knowledge *will* save, and this with a growing salvation.

If the professors of Latin and Greek recognize that they are not solely or chiefly professors of philology—but rather that they are appointed to acquaint the scholar with *literatures* transcendent in their beauty of form, their wealth of imagery, and their depth of thought —if the professors of Latin and Greek recognize the true method of doing this great work, classical study will never be neglected. All this is equally true of the instructors in physical science. The distinction between a fact seen in the dry light of its naked isolation and the same fact as part of an organic and amazing whole is the distinction between life and death in the teaching of science.

To employ a certain kind of teaching (which is in *no sense* teaching), and to expect educational reform by confining a boy to physical science or to classics, is a colossal mistake. To pay the lowest wages in the primary grades of our schools, where the best teaching is imperatively needed, is an equally impressive blunder. To engage a professor for *what* he knows, for the number of books he has written, for the amount of original work he has done, is—to do a grand thing for the professor, but by no means necessarily a grand thing for the pupil. Most of the young men and women in American colleges *need to be taught.* Is this to decry research or the establishment of all means for discovery? Rather is it to discriminate between the work of teaching and the work of investigation. Is a man called to teach, is he employed to teach, is he paid to teach—let him, then, teach, i. e., let him spend himself in the work of education. Were every teacher, nay, were the majority of teachers, to see in the pupil the pupil, there would be a reforming of education such as has not yet been experienced.

We close this paper by such a brief statement of the opposing ideas previously mentioned as may best serve to show their reality.

Fortunately, our purpose has been already served by a few contrasting paragraphs admirably conceived and expressed :

I. "From the standpoint of humanism education has its own purpose *in itself*, viz., universal culture of man. According to philanthropism, education has *not* its purpose in itself, but only a *relative* purpose, viz., the training of man for a future avocation.

II. "From the point of view of humanism it is not, in education, so much matter of chief importance to *collect knowledge* as to discipline the spirit by it. From the point of view of philanthropism, the aim is to fill the mind with the largest possible amount of useful information.

III. "Humanism exercises the mind of the student not so much to make him apt for some appointed business—*culture of the spirit is here an end in itself.* With philanthropism culture is something aimless in so far as the spirit is not made more apt by it for some special business.

IV. "As respects the objects of education, humanism does not require many objects by which the youth is distracted and prevented from thorough acquisition. The pupil should be advanced by a few objects to the highest degree of knowledge.

"Philanthropism, on the other hand, in view of the daily increasing territory of what may be known, does not dare confine itself to holding the youth throughout his entire period of education to a few objects—much rather attention should be paid to rendering easy the circle of objects, that the child may be offered the greatest possible amount of knowledge.

V. "Humanism brings before the youth single departments of knowledge in the *entire manifoldness of their separate objects*, then teaches to arrange these objects with *exact system*, thereby to accustom the student to logical thinking, so that, when later he ventures upon outlying territories of knowledge, he will not fall into error. Philanthropism would broaden instruction, to cover as far as possible the entire field of knowledge, because he who has not a view of the whole must possess only half-way and distorted impressions concerning the separate departments of knowledge and their particular objects.

VI. "According to humanism, not *things* but *ideas* are best adapted to the exercise of the spirit, that the youth may not, during his future, active life lose himself in the region of bread-and-butter knowledge. Philanthropism demands for this very mental exercise not ideas (which strictly considered are only words), but *things*, and this in order that the mind, perpetually occupied with letters and words empty of content, may not lose itself in the region of mere word-knowledge, and become good for nothing in practical life."

These ideas of man and of his place in the world are fundamentally distinct. They can never be done away or disregarded, for they root themselves in the twofold nature of man. It is possible to be a humanist or a philanthropist in education both with sincerity and with reason. There is a seed of truth in each half of these contrasts, and it is more than probable that, despite all attempts at adjustment, men will be born humanists and philanthropists to the end of time.*

COMTE AND SPENCER ON SOCIOLOGY.†

By LEON METCHNIKOFF.

THE most momentous intellectual conquest of our days is, perhaps, the discovery of the great law of the unity and continuity of life, generally styled the law of evolution. Not only are the remotest branches of knowledge—as, e. g., physics and psychology, or chemistry and politics—connected by it into a systematic and harmonious whole; but by it also has been realized that union between science and philosophy for which the clearest minds of former ages longed in vain. The secular feud between idealists and materialists ceases on the solid ground of the evolutionary doctrine, where every science becomes philosophical without surrendering to any metaphysical or *a priori* conception; while, on the other hand, our psychological and ethical inquiries acquire a firm basis and scientific precision and accuracy as soon as they are touched by the vivifying spirit of this theory.

Since we admit the unity of life, and since we consider cosmic phenomena, in spite of their amazing apparent diversity, only as various manifestations or consecutive degrees of one evolution, we are compelled to infer that our methods of political or historical knowledge ought to be essentially identical with those generally prevailing in physical or biological researches. Metaphysical speculations on social matters, in which the greatest philosophers of former centuries delighted, lose their hold upon the skeptical mind of our age, and even the economic empiricism of Adam Smith, Malthus, and Ricardo, grows inadequate to the modern demand for positive knowledge of the natural laws pervading the evolution of human societies. Sociology, i. e., a strictly scientific statement of these laws, is considered nowadays as an integral part, as the necessary "*couronnement de l'édifice*" of a methodical conception of the world. The very name of sociology has been created *ad hoc* by Comte, who esteemed himself to be the

* In closing the more distinctly historical portions of these articles, I desire again to express my indebtedness to the foreign histories of education. From such a work as Schmidt's "Geschichte" I have made selection and condensation as seemed best to serve my purpose.

It will be understood that for all criticisms and opinions, e. g., on English deism, on classical study, I am alone responsible.

† From an article entitled "Revolution and Evolution," in the "Contemporary Review" for September, 1886.

founder of that *Novum Organum* or gospel of modern intellectual regeneration.

In his classification of sciences, based upon their increasing concreteness and speciality, he states that science, though essentially one in opposition to metaphysics and theology, ought to be divided into branches, or sciences in a more restricted acceptation of the word, each of them corresponding to a well-defined series, the number of which he fixed at six, as follows: first, Mathematics; second, Astronomy; third, Physics; fourth, Chemistry; fifth, Biology; and sixth, Sociology.

Without insisting upon the number of these divisions or their philosophic value, I shall only consider the limits of sociology as they have been traced by the master-hand of the French patriarch of that strange mixture of knowledge and faith ("Catholicism *minus* Christ and *plus* erudition," as it has been styled), which still holds sway over so many minds under the name of the Positive Philosophy, and the peculiarities of which are partly due to the depressed state of his health at the time when he wrote his most important sociological works, and partly, perhaps, to his native pedagogic whims.

According to Comte, sociology ought to be a science, so to speak, exclusively human. Social facts may be common in the life of animals, and even of plants, but he entreats the sociologists of his school not to pay them any attention. While other sciences are cultivated for the sake of truth, Comte would have sociology to be learned only for the sake of human morality. As to the methods of sociological research, he admitted them in his first writings to be similar to the strictly scientific methods of observation and induction, but he soon retracted that admission, and declared that skeptical analysis ought not to enter the sacred precincts, synthesis alone being worthy of such elevated study. Thus he voluntarily created an abyss between science and sociology.

Referring to the limits and object of sociology, the statements of the great founder of the French positive philosophy appear, in certain respects, far more worthy of acceptance. Selecting, arbitrarily, the human individual as the starting-point of his researches, he observes that one part only of our activity is based upon egoistic instincts arising from need of nutrition or personal preservation in general; that part, including our uppermost psychological recesses, belongs to the biological domain. Sociology includes the remainder—viz., that part of human activity which is based not upon individual self-satisfaction, but upon what he calls *altruistic* instincts, supposing them to be inherent in every living being. The physiological roots of *altruism* he perceives in the sexual attraction, the natural result of which is the *association* of a male and a female for the preservation of species—an end not personal to either of them.

A psychologist would observe, first, that Comte uses the word "instinct" in a sense which is not very clear and is throughout unscientific; for, according to modern researches,* we do "*instinctively*," i. e., unconsciously, that which previously we did knowingly, and thus to account for an "instinct" as a *primum movens* sounds somewhat like the "purgative force of the rhubarb"; secondly, that the distinction he makes between egoistic and altruistic instincts is superficial. From the subjective point of view, it is obvious that whether they act under the impulse of sexual attraction or under that of hunger, individuals aim merely at the satisfaction of physiological (egoistic) want; nor are their objective results so essentially different as Comte pretends; hunger as well as sexual attraction is able to lead men and animals—in some cases to struggle, in others to *co-operation*. And, if he did not exclude the social life of animals from the field of his humanitarian sociology, he might easily perceive that associations for food or for self-defense have generally a far more social character than primitive conjugal alliances for progeny.

Nevertheless, the greatest, perhaps the only valuable, service rendered by Comte to social science lay in the very clear distinction he made between the sociological and the biological domains, when he referred to sociology only such aggregation of individuals as is based on *co-operation*, conscious or unconscious, and abandoned groupings based on struggle to biology. Thus, I may say, he opened the door of true social science without himself entering its precincts, and, unfortunately, I must add, misleading his followers with his erroneous statements as to the unavoidable subjectivity of the methods of social knowledge. I insist upon that high service; that remarkable definition of the boundaries and of the object of sociology appears, so to say, drowned amid the numberless quaintnesses of his whole system, and none of his admirers, orthodox or schismatic, have ever cared so far as to disengage from his hardly readable volumes the few lines.

Owing to his restricted acknowledgment of the principle of the unity of Nature, Comte appears, at any rate, scarcely a precursor of the modern scientific evolutionism. Looking for a more complete and methodical compendium of that theory, we have to cross the Channel and to approach Herbert Spencer's "First Principles," and his many other valuable essays on ethical, political, and other sociological subjects. No mind could perceive more perspicuously than Herbert Spencer does the admirable unity of Nature, and no pen could describe it with half so much clearness and attraction as his. While the science of Comte, always behind his age, appears like a mosaic of six stray pieces—and the author takes painful heed to make us feel the gaps which he supposes really to exist between them—the science of Spencer on more than one point gets the start of the erudition of modern specialists, and is throughout livingly and harmoniously one, according to the unity of Nature.

* Romanes, various writings; also A. Herzen, "Studii fisiologici sopra la volontà."

In the system of Spencer, as in that of Comte, sociology appears at the top of the scientific series, but with him this pinnacle of knowledge is really and solidly connected with the building itself. In spite of their much greater complexity, social phenomena are essentially identical with those of inferior cosmic life. Sociology for Herbert Spencer is a physical science like others, requiring no peculiar synthetic or subjective methods, and its aim with him can not be any other than the reduction of the specific laws of social life to the universal laws of motion.

Passing to the delimitation of the sociological domain and to the definition of the object of that science by Herbert Spencer, I must observe that those matters, in modern evolutionism, present a degree of complication which Comte avoided by the artificial isolation he created for sociology in his philosophical system. Natural science teaches us that association is the law of every existence. What we usually call society in common speech is only a particular case of that general law. A being, whether social or not, is never absolute, indivisible; but essentially comparative and multiple, resulting from the action of a number of forces converging on one point.

Political and social systems speak a good deal about "individual" and "society"; but the very point where the individual ends and society begins has never yet been fixed with any accuracy. The most prominent botanists and zoölogists, who have to deal with this matter for their own technical purposes, have been led to acknowledge several degrees of individuality: we can consider each individual as a whole, or a person, in comparison with the individuals of a degree beneath it; but when we compare it with the individuality of a superior degree, it soon loses its personality and appears as a part, a member, or an organ. There are myriads of plants (*algæ*) and animals (*infusoriæ*), which are styled monocellules, and which, indeed, are considered as consisting of one single organic element or cell, although their anatomical structure appears, sometimes, very complex and perfect in its peculiar style. But organic cells quite identical with these form also aggregations, or associations, more or less compound; and such groups of cells either live independently, unfolding their own botanical or zoloögical individuality, or enter, in the shape of textures and organs, into the composition of other still superior individual beings. Men, like other *mammalia*, are, in fact, associations of such colonies of cells. Our inveterate tendency to consider ourselves as an end and a center of the creation makes us prone to prejudge that our own individuality is the only genuine one.

It would be hardly possible to review in a few lines the remarkable researches into the various degrees of vegetable and animal individuality of Nägeli, Virchow, Huxley, Haeckel, and many others; and it is beyond my competence to settle whether absolute individuality, i. e., morphological indivisibility, ought to be granted to cells—as was asserted till the last few years by the most authoritative scholars—or whether organic cells themselves consist of individualized elements (*plastids*) still more primordial. But that is not intimately connected with the main object of the present essay, and the biologists are now somewhat at variance on the point. I shall only observe that the great De Candolle distinguished six degrees of individuality in plants alone; Schleiden reduced that number to three (the cell, the shoot, the *cormus* or stock); while Haeckel, again, doubled that number. For shortness' sake, we may admit the classification very recently (in 1883) proposed by a young Italian scholar, M. Cattaneo,* who, considering the question from a zoölogical point of view, fixed the number of such degrees of individuality at four, as follows: 1. *Plastids*, i. e., cells or any other primordial elements, after dividing which we should get not a being of any kind, but mere amorphic organic matter; 2. *Merids*, i. e., colonies of such plastids; 3. *Zoïds*, i. e., such individuals as are autonomous so far as their individual preservation is concerned, but which are obliged to unite with other individuals of the same series for preservation of species (like superior animals and men); and, 4. *Dems*, i. e., colonies of zoïds: conjugal couples or pairs, families, tribes, societies.

Assuming that the proper aim of sociology is the investigation of the natural laws regulating the connections between individuals and society, it is obvious that, before we approach sociological studies themselves, we must answer the preliminary question, Which of the various degrees of individuality above mentioned we accept as the starting-point of our researches; or, in other terms, where ought the domain of social science properly to begin?

For Comte social life begins as soon as two individuals of the series of *zoïds* (he explicitly says, man and woman) unite themselves in a conjugal pair, the result of which union is the arising of a *dem*, i. e., a compound individual of a superior species. Thus he asks us to look for the object of sociology, not in the material fact of an aggregation, but in the *consensus* or convergence of forces represented by the uniting individuals, aiming at an end which is personal to none of them. In that sense his teaching seems to be of capital significance for the progress of the real social science. But that meaning can be only obtained from the spirit of his doctrine, not from its letter; and the great philosopher himself was more than once false to his own premises. It seems that Comte was not fully aware of the extreme difficulty of settling in a scientific sense the point where individual life becomes social, and we hasten to see how the far more learned English evolutionist—I mean Herbert Spencer—gets out of the whirlpool where the ship of the French positive philosophy foundered with all hands on board.

In his "Principles of Sociology" Herbert Spencer pays but little

* "Le colonie lineari e la morfologia dei molluschi."

attention to these preliminary questions as to the limits and the specific laws of sociology; and we are compelled to go back as far as his "First Principles," etc., to get a knowledge of the way in which those questions are answered by his system. This is to be regretted, not so much because of the practical inconvenience of perusing many volumes about matters but indirectly connected with the object of our researches, but far more on account of the impossibility of summarily reviewing so monumental a work in the few pages of this essay.

To French positivism, sociology appeared too much isolated from genuine knowledge by a gulf which Comte asserted to be unfathomable. With the modern scientific school, the danger comes rather from the opposite side, and sociology is threatened, so to say, with being swallowed up, or absorbed, by zoölogy.

Indeed, to botanists and zoölogists is due the capital discovery of the unquestionable fact that (with the single exception of the lowest monocellular ones) organisms are societies. And if we were arbitrarily to reserve the appellation of society exclusively to the *dems* of M. Cattaneo's classification, still we could not get out of the difficulty even by such an anthropomorphic (i. e., anti-scientific) restriction. An "organism is a society"—that great sensational thesis is imposed on our mind more and more with every new advance of natural science; while, on the other hand, the chief sociologists of these later years, starting from their more or less synthetic point of view, come to the conclusion that "society is an organism." * The great Darwinian law of the struggle for life, which is the specific law of evolutionary biology, plays a part still more and more prominent in the most recent sociological writings, and the very object of social science appears to be well-nigh dissolved in the vast domain of biology.

THE HICKORY-NUTS OF NORTH AMERICA.

By JOSEPH F. JAMES.

IT is a favorite pastime of our country population during the long winter evenings to gather round the fire and crack and eat hickory-nuts. It is an amusement, too, peculiarly American, and for the simple reason that in this country alone are the nuts to be had in any abundance. Perhaps, where almonds or English walnuts are equally common, cracking hickory-nuts is superseded by a resort to these other fruits. They, however, are much easier to open than the hickory-nut, and with thinner shells are readily cracked at the table. But in America, in those districts where the peanut does not take the place of other nuts, the cracking of the hickory still continues. Whether it

* See the "Revue Philosophique" of M. Ribot, for 1883, *passim*.

be the pecan of Texas and Illinois, or the shell-bark or mocker-nut of the Central or Eastern States, the amusement is the same. They are the best nuts the forests of North America produce, and some of them are thought to be superior in flavor to the much-esteemed English walnut.

Year after year have hundreds and thousands of bushels of the shell-barks, the hickory-nuts *par excellence*, been gathered in various parts of the country. Among these, few can have failed to notice the many differences they present. Some are small and nearly round; some are long, narrow, and angular; some have thick shells, and some thin ones, as any one who has cracked his fingers along with the shell can bear witness.

According to evolutionary doctrines, variability in an important feature is an indication either of a low state of development, or that the organism is in a state of advancement. Various facts show the latter to be the case with the shell-bark hickory. The first stages of the onward march must be sought far back in prehistoric times, for it boasts an ancient if not an honored lineage. Before the hairy mammoth roamed the forests of the Ohio Valley; before the soil of Louisiana was yet above the ocean's waters; before the Ohio had become tributary to the mighty Mississippi; before even the Rocky Mountain range had been elevated above the waste of waters, the ancestors of this hickory flourished in the land. But, before we study the ancient hickories, let us examine the living trees and note their peculiarities.

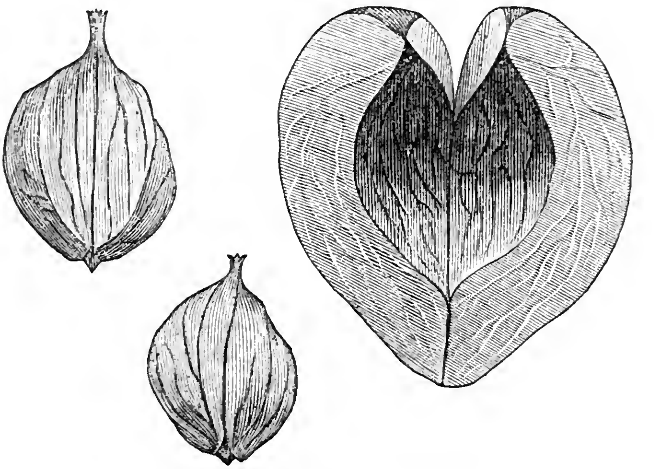

Fig. 1.—White Shell-bark (*Carya alba*).

Were the same observers who saw the differences in the size and shape of the nuts of the white shell-bark to direct their attention to the husks of that fruit, they would find much variability there also. But these are secondary considerations with the nut-gatherers. If a nut falls to the ground with the husk intact, the nutter gives it a kick with his boot-heel, or a blow with his stick, and separates the husk into its component parts. For this outer covering divides readily along the sutures and falls into four pieces. Sometimes the four form a nearly perfect ball; sometimes they are long and taper to a point; occasionally, three pieces will serve the purpose of four, but they are all dark green or brown on the outside, white with streaks or veins of brown inside, and they vary from a quarter to half an inch in thickness.

Yet another thing will the nutters notice, and that to their disappointment and disgust. This is the number of nuts having neatly cut, round holes in the shell. Out of these there will often be seen protruding the white body of a well-fed worm, which has been growing in size and strength since the egg hatched in the young nut. The grub grew with the growth of its house; it found an abundant store of nutriment, and it attains a size which makes it a matter of wonder how it manages to escape from the neat little round hole it has cut in the thin white shell.

Such is the fruit of the white shell-bark. The tree which produces it is equally interesting. The common name of shell-bark or shag-bark tells at once its most remarkable characteristic, and one by means of which it is most easily and readily recognized. The bark, instead of being securely attached to the trunk as in most trees, breaks loose from it and hangs in strips, fastened sometimes in the middle, sometimes at the upper and at other times at the lower end. The whole trunk thus presents a shaggy, rough appearance, and in some cases resembles the ragged ends of an ill-laid and worn-out thatch. This feature is only to be observed in trees of more than ten years of age, younger ones showing indications of what is to come.

It is a majestic tree, eighty or ninety feet in height, straight and without a branch for sometimes sixty feet, and then spreading out its bushy head. In the spring the young leaves make a very rapid growth, attaining a length of twenty inches in a short time. These leaves are divided into five leaflets, four being in two opposite pairs, and the fifth placed at the end. Each leaflet tapers to a sharp point and has saw-like teeth on the edges. The flowers are small, green, and form long, pendent catkins, arranged in bunches of threes, with the fertile or pistillate flowers at the base. The pollen is produced in immense quantities, and conveyed from the stamens to the pistils through the agency of the wind. The species is widely distributed over the country, ranging from the St. Lawrence Valley and Southeast Minnesota on the north, to Florida and Texas on the south. This extensive dispersion is perhaps one reason for the variability the nut presents, as under varied conditions it assumes diverse forms.

One of the nearest relatives of the white shell-bark is the thick shell-bark. In this species the nut is very large, has an extremely thick husk and shell, and a small but sweet kernel. The husk separates into pieces, the flowers are alike, and the bark exfoliates in much the same way in both. There are, however, often seven instead of five leaflets, but they have a pointed apex and serrate edges. The tree is not so widely distributed over the country, as it is found mainly in the Mississippi Valley, north of the Ohio River. The very heavy shell, requiring severe blows with a hammer to crack, makes the reason for this more limited diffusion obvious. Depending almost solely on rodents for its dispersal, the size of the nuts preventing the wind from carrying them to any distance, the heavy shell makes it a most difficult task for the gnawers to penetrate to the kernel within. It will be readily understood that the thinner and yet sweet-kerneled nuts will be chosen in preference. And while mice and woodchucks and chipmunks and squirrels will lay up stores of the thin-shelled nuts, often carrying them long distances, the heavy-shelled ones will seldom be molested, but remain where they fell near the parent tree. The heavy shell would, again, be an impediment to germination, and thus fewer individuals would grow, and those which did sprout would have little chance of attaining maturity while overshadowed by the older tree. Thus we have a simple explanation of the fact of the limited distribution and the small number of individuals in any given area.

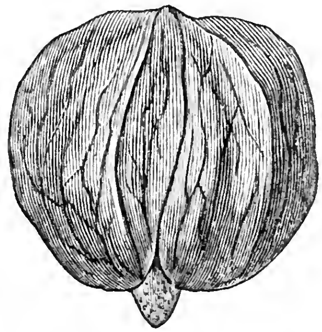

FIG. 2.—THICK SHELL-BARK (*Carya sulcata*).

The near ally of this species is another heavy-shelled sort, the mocker-nut, which has a much thinner husk and yet a thick shell.

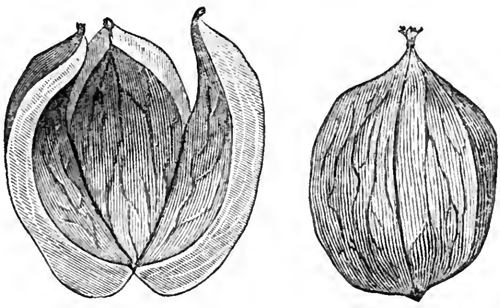

FIG. 3.—MOCKER-NUT (*Carya tomentosa*).

The nut is quite large, intermediate in size between the white and the thick shell-bark, of a yellowish color and a sweet kernel. The bark has not the scaling propensity, but the flowers and the leaves are quite similar. Its distribution is wider than the thick shell-bark, but it is still limited. One peculiarity is observed in all three species, and that is the great variability in the shape of the nuts, a feature that is much less marked in all the other sorts.

The white shell-bark occupies a sort of intermediate position in the genus. On one hand are the thick-shelled species already noted, forming one line, and on another line are two species marked in other ways, but mainly by a difference in the kernel. While in the three already described this is sweet and palatable, in these other two it is bitter and uneatable. These have, also, thin instead of thick husks, and they separate only about half-way down instead of into four distinct pieces. The shell is thin, so much so in some cases as to be easily crushed in the fingers. In size, shape, and markings there is none of the variability of the shell-bark. Of the two species the bitter-nut is

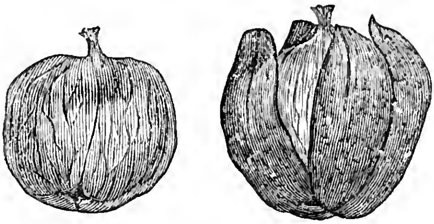

FIG. 4.—BITTER-NUT (*Carya amara*).

the more common. The bark is close ; the tree grows to be forty or fifty feet high, the shell is smooth, sharp-pointed, and marked with lines, while the kernel is so bitter that it is rejected by squirrels and other animals as long as other food can be obtained. The leaflets are small, from seven to nine in number. Its distribution is limited to nearly the same area as the mocker-nut, namely, the valleys of the Ohio and its tributaries, Minnesota, Kansas, and Western New York.

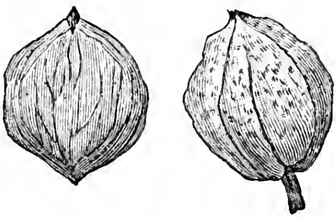

FIG. 5.—WATER-HICKORY (*Carya aquatica*).

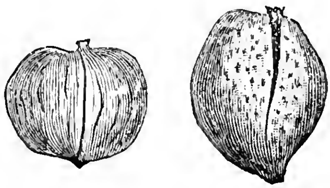

FIG. 6.—SMALL-FRUITED HICKORY (*Carya microcarpa*).

The water-hickory has many of the same features, but the shell of the nut is thinner still, and the kernel yet more bitter, while the tree is confined to the swamps of Carolina and Georgia, where it is by no means common. Its nut is of a reddish color, and more or less angular.

On a third line running from the white shell-bark are three other species. One of these is the small-fruited hickory, in which the husk and the shell are both thin, and the kernel, though small, is eatable. It is closely allied to the white shell-bark, and by some considered a variety only. A second species is the pig-nut, which has a thin husk but a thick shell. The kernel is small, and, though agreeable at first, soon becomes bitter and disagreeable. It is never eaten by man, but

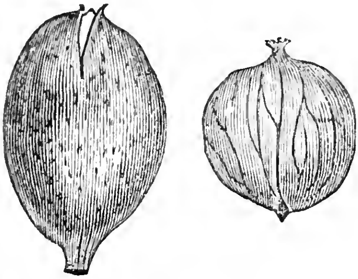

Fig. 7.—Pig-nut Hickory (*Carya porcina*).

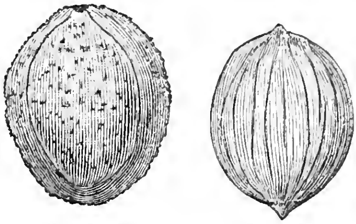

Fig. 8.—Nutmeg Hickory (*Carya myristicæformis*).

used to feed hogs, or left for the wild animals. This nut is somewhat variable in shape, sometimes being distinctly pear-shaped and then again round. Michaux says that the same tree yields nuts as large as the thumb and others as small as the little finger. The third species in this same line is the nutmeg hickory, which has a somewhat rough husk, with a smooth nut, lined with streaks of white, and a shell so thick as to constitute one half of the whole nut. The kernel is inferior even to the pig-nut hickory.

If all these species were to be arranged so as to show their affinities, something like the following diagram would result:

```
Nutmeg hickory,
    \
  Pig-nut hickory,                    Mocker-nut,
          \                           /
     Small-fruited hickory,    Thick shell-bark,
                 \                 /
                White shell-bark,
                       |
                   Bitter-nut,
                       |
                 Water-hickory.
```

From facts already given it will at once be apparent that two features in the nuts are correlated. The thick-shelled nuts have sweet kernels, though they differ in edibility, and the thin-shelled ones are invariably bitter. Thus the sweet ones protect their kernels by incasing them in hard shells—a precaution unnecessary for those whose kernels are bitter, because they are protected by this feature alone.

There remains, now, one species to be considered, and that is the pecan. While the white shell-bark seems to occupy a central place among the species, the pecan is intermediate between the hickories and the walnuts. These two genera, *Carya* and *Juglans*, as botanists know them, constitute the main part of the order to which they belong. When two genera are as closely allied as these are, an evolutionist accords a common origin to both. In fact, the difference between the two is a technical and comparatively an unimportant one.

It is the presence in the hickories of staminate flowers in clusters of threes, while in the walnuts there is but one; and by the more or less complete separation of the husks of the hickories into four pieces, while the walnuts have no such division.

Now, the pecan is allied to the walnuts by the number of its leaflets (thirteen to fifteen, while the walnuts have, in one species, seven to eleven, and in others fifteen to twenty-one), and by having its catkins separated at the base instead of being united. And it agrees with the hickories in having three catkins instead of one, and by the husk of the fruit separating into four pieces. The kernel is very sweet, the husk is thin, and the nut smooth and rather thin-shelled. The peculiar feature of a bitter division between the two halves of the nut is an approach to those hickories having a bitter kernel: while the hard shell and the sweet kernel ally it to the shell-bark. The tree is confined now to the States near or bordering the Mississippi River, and is thus the nearest of all the species to that spot which was once thickly clothed by its ancestors. It is noteworthy, too, that the walnuts approach the same habitat, and in the case of one species extend across the continent to California.

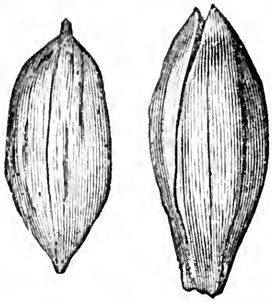

Fig. 9.—Pecan (*Carya olivæformis*).

From an aboriginal ancestor which probably possessed a many-parted leaf, and a fruit with an entire husk and a thick shell, there came two branches. One of these, retaining the numerous leaflets, developed a nut with a corrugated shell and a thick, green husk, represented by the living species of walnuts. The other branch gave rise to a species having a nut resembling the pecan, with a smooth shell, and a husk separating more or less completely into four parts. Some of the various stages of development from such an ancestor have probably been preserved to us. The white shell-bark may be regarded as a modified descendant in which the bitter internal division has been lost, and the outer shell strengthened to afford additional protection. The mocker-nut and the thick shell-bark have acquired a still stronger covering to protect them in the same way. The small-fruited hickory is probably a stepping-stone to the pig-nut, with its thick shell and partially bitter kernel; while the thin-shelled bitter-nut and water hickory are other offshoots in which the bitter kernel does away with any necessity for a hard and thick shell.

The geographical distribution of any species or genus is an interesting and important adjunct to its history. At the present day, all the species of hickories are natives of North America east of the Rocky Mountains. Two out of four of the species of walnuts are confined to the same limits; a third is native to California and Mexico;

and the fourth, the English walnut, is a native of Persia and the Caucasus. In times past the distribution was far different. What information we have is derived only from a confessedly imperfect geological record—a record exposed and explored as yet in the Rocky Mountain region, in Alaska, Greenland, and Central Europe. In all of these places species of either the one or the other genus have been found. It is true that the determination of species or even genera is difficnlt from fragments of leaves, but, as far as is now known, the following are the facts:

During that period of time known as the Cretaceous epoch, a tropical climate prevailed over the whole of the northern hemisphere, even to the pole itself, and probably also over the whole world. During that time forests of trees flourished over the continent of North America, over Europe, and probably Asia also. These forests were, in many respects, similar in aspect to those which at present clothe portions of the Ohio Valley. What species of trees lived in that part of the country north of Virginia and Tennessee and east of the Mississippi, it is now impossible to tell. But west of that river, and over the larger part of the Rocky Mountain region, there grew forests in which poplars, willows, oaks, beeches, sycamores, gums, magnolias, and perhaps walnuts and hickories, were the prevailing types. The remains of all but the last two have been found in the immense series of Cretaceous rocks of the Western States and Territories, having fortunately been preserved in the deposits of the shallow seas or great lakes which then occupied that part of the American Continent. The genera mentioned are but a few of those of which remains have been found, but they indicate a similarity in the flora then to that of the present epoch. Many of the same genera are found in strata, of presumably the same age, in Alaska, Greenland, and parts of Europe, and these facts indicate not only a similar climate in all these localities, but a similar forest aspect.

In the Tertiary formations, coming after the Cretaceous, the resemblance to modern trees is still more striking. During this later period, that part of the Rocky Mountain region which had before been under water was elevated above the surface, but immense basins remained which were filled with brackish or fresh water. It is in these fresh-water deposits that the abundant remains of ancient forests are found. Many of the same types present in the Cretaceous period are found in the Tertiary in still greater numbers. If there be any doubt about the occurrence of walnuts and hickories in the former period, there can be no question about their being in the latter one. The number of species of oaks, poplars, figs, ashes, magnolias, and many others equally well known, was increased. But we shall here consider the two genera, the walnut and the hickory.

In Europe one species of walnut is found in the Cretaceous rocks, and a doubtful one is mentioned as found in rocks of the same age in

America. The lowest series of Tertiary rocks in Europe contains remains of three species, and the upper series of no less than forty-three species. The hickory seems to have appeared in Europe in the middle Tertiary, and in the upper beds is represented by twenty-one species. In America the walnut is well represented in the lowest Tertiary, and increases in numbers toward the top; while the hickory is represented by several species through the whole series. When the living species of these two genera are considered, a widely different state of affairs appears. The forty-three species of walnuts dwindle to one; the hickories are entirely absent, though perhaps represented by three somewhat different genera now growing in Japan and parts of India.

The fact that many genera of Tertiary plants are common to North America, the Arctic regions, and Central Europe, is evidence of some former land connection. This connection was probably at the northern ends of the continents, and it allowed the free commingling of the floras of the two bodies of land. When at the close of the Tertiary vast changes took place in the distribution of land and water; and when a wave of extermination swept over the northern and western portion of this continent, the same disaster overtook the forests of Europe. The eastern half of North America and the eastern part of Asia seem to have escaped the effects of the vast change; for in these two regions are still found the remnants of the previous floras. Europe and the Rocky Mountain region suffered from the throes of mountain-making, and the disastrous effects of these convulsions are shown in the extinction of the luxuriant flora and the varied fauna which had previously existed.

Thus it can be seen that our hickory can boast a pedigree which puts to shame the mushroom-growth of modern days; and, while the descent can not be traced in a direct line through all the intermediate stages, we can safely formulate the main facts. The ancestor of both walnut and hickory orignated toward the beginning of the Cretaceous period. The separation of the two occurred toward the end of the same epoch, and they both spread during the highly favorable period of the Tertiary over the whole country and across the Arctic zone into Europe and Asia. The continental condition of Eastern North America and its lack of large, shallow lakes forbade the preservation of such forms as existed there; and the comparatively small portion of our Western region which has been explored has prevented the discovery of many of the species then living there. Yet there can be little doubt but that, if our knowledge of pre-existing species was sufficiently full, we should be able to trace back to some common ancestor all nine of those species of hickory which now live in our country, and the fruits of some of which annually contribute to the enjoyment of hundreds and thousands of our people.

THE HYGIENIC TREATMENT OF CONSUMPTION.

By BENJAMIN WARD RICHARDSON, M.D., F.R.S.

THE progress of hygienic medicine in the last fifty years is the medical fact of the present age, and the fact that will stand out in boldest relief when the history of this period shall be written by some future Æsculapian scholar.

But, rapid and effective as this progress has been, the principles of hygiene are yet in their infancy. We have learned to appreciate the true value of hygienic principles in the prevention of diseases of the epidemic type ; and the medical profession, throwing aside all selfish recollections, has been the first to teach the practice of these principles and to prove their force and vitality. The next step in the way of advancement is to demonstrate that the same principles are as useful and as necessary in the treatment of actual disease as they are in prevention.

A great advantage in the hygienic treatment of disease is, that it does not, or at least need not, interfere with sound and experience-proved modes of treatment of a medicinal kind. The scientific physician finds, in fact, that there is always a consistent plan for combining the medicinal and hygienic systems. He sees that the two systems are one ; he sees further that the mere medicinal plan without the hygienic is in all cases imperfect, and in some cases worse then imperfect.

The practical details of hygienic medicine in relation to the treatment of disease have, however, yet to be wrought out more fully. This will be sure work, but slow. Necessarily slow, because it is hard to give up old friendships in dogmatism ; while to effect a cure in a sick man by fresh air alone, or diet, is infinitely less satisfactory to the public than to assume to effect the same cure even by a bread-pill.

It is vain, it is sticking in the slough of hopelessness, to pander to these popular weaknesses ; for though they must die out, and, indeed, are dying out daily, they will go the sooner if they are effectually damped, and if something real and common sense is put in their place. *Scientiæ mutantur, et nos mutamur in illis.* There is a time when medicines are invaluable ; but, if faith in medicines is to be retained, the times for their administration, as well as their selection, must be learned by knowledge, not by routine, and must be dictated by the circumstances of the case, not by the caprice of the patient. The executive of medicine must be independent, if it would keep in the path of truth and advancement.

In such progress as has been made in the science of treatment by medicines, it has been found useful to take up certain particular diseases, and to observe in them, individually, the effects of particular remedies. This rule will apply with equal force in considering and investigating hygienic modes of treatment. Each practitioner should, as his opportunities permit, observe as carefully the effects of his hygienic commands as he does those of the medicines he may prescribe. He should compare also the one mode with the other, and calculate in each case their relative advantages. In this way he will have the opportunity of detecting with greater accuracy the pure effects of medicines themselves; seeing that the action of medicines is greatly modified by the external conditions to which he who takes them is subjected.

Convinced of the importance of the above considerations, I have made it my business for thirty years past to mark out a series of hygienic rules for the treatment of consumptives; and as I have had the best and widest opportunities of carrying out these rules in practice, and as the results have been satisfactory, I lay the views published, originally, while I was one of the physicians to the Royal Infirmary for Diseases of the Chest, once again, and briefly, before the public.

In giving the following rules, I presuppose their general applicability to cases of consumption in all stages of the disease: in the premonitory stage; in the stage when the tubercular deposition is evident; and in the next stage, when the local mischief is much further advanced. In the last stage even, though hope is lost, many of the rules may still be followed out with advantage, for by them the course of the disease is smoothed, and sometimes life is prolonged. In like manner, the rules are generally applicable to those who by hereditary taint are as yet but predisposed to the disease.

RULE I. *A Supply of Pure Air for Respiration is the First Indication in the Treatment of the Consumptive Patient.*—In all cases of consumption, the attention of the physician should be at once directed to the quality of the air breathed by the patient.

In large cities, and even in small towns, it is next to impossible to get a constant supply of pure air in inhabited houses; for houses are built according to false notions of comfort. "What a nice, cozy room!" is a common expression applied innocently to every place where the greatest care has been taken to make an air-vault, without a "draught," and all ready for being charged with invisible impurities.

In a cozy room the consumptive is bound never to live, nor, indeed, in any one room for great lengths of time. So long as he is able to be out-of-doors, he is in his best and safest home. In the fields, on the hills, wherever the fresh air vivifies, where plants look most vigorous, and animals frisk about in the joy of health, there will the consumptive draw in his choicest medicine, there meet most advantageously the dangers of his disease, and there repair most easily the waste of tissue.

The inclemencies of the weather may temporarily, it is true, prevent the patient from his out-door existence. But even these inclemencies are not so much to be dreaded as confinement in a house. I have had occasion repeatedly to remark that if, from a few days' rain, the consumptives under my care were confined to their homes, instead of being able to take the daily out-door breathing invariably prescribed under such circumstances, the aggravation of symptoms was always marked and universal. The appetite fell off, the debility became greater, the mind was less buoyant, the local mischief increased. The patients, too, previously accustomed to a full dose of the air-food, were not ignorant of the cause of these changes, for reduction in air is felt as quickly as reduction in common diet. Seeing these evils, then, I have long since thrown off the alarm about bad weather, and have ordered every patient to seize, even in an inclement day, each gleam of sunshine, for the purpose of getting out for a breath of fresh air. The result of this practice has been most gratifying in all cases where the courage of the patient has admitted of its application.

Dr. Jackson, in speaking of out-door life, in much the same terms as the above, dwells very properly on the necessity of securing for this plan the confidence of the patient. The treatment "should not be done rashly, but boldly." If possible, "the patient should be made to have faith in it ; for without this he is not likely to pursue it as far as he can, and then he will not derive from it all the benefit which it can afford." This is the fact ; but the difficulty is at once got over if, under favorable conditions, the invalid can be induced to try the measure for a few days. Once tried, there is no fear, in the majority of cases, of its being given up, except in instances where the disease is too far advanced, or where, from the poverty of the patient, the pursuit of a sedentary occupation must needs be followed, even to the last days of existence. The benefit derived from this treatment is indeed so obvious, the debility is so much better borne, the relish for food is so much more markedly felt, the nights are passed with so much less of restlessness and cough, and with such an increase of sleep, that the sufferer soon instinctively feels the value of his instructions, and follows them out even more punctually than those which relate to the taking of medicines.

As much of the day, then, as is possible should be spent by the consumptive in the open air, and in places where the air is least impeded and least corrupted. When he is compelled to keep the house, the necessary precautions must again be taken for procuring a free admission of the atmosphere. No cozy room with a temperature of 70°, with every crevice closed, and with an atmosphere in a dead calm and laden with impurities, should be permitted. But the temperature should be 60° Fahr. ; the fire, if there be one, should be in an open grate ; and by a free chimney-vent, secured by an Arnott valve, the freest possible current of air should be kept circulating through the room. If the patient is cold, let him approach the fire, but let him not labor under the popular and fatal error that the way to obtain animal warmth is to shut out the air and roast the body. The heat of the body is made in the body itself, by virtue mainly of the oxygen supplied in the air; and, as the body absorbs external heat with great difficulty, it would be as wise to attempt to give warmth by fires, hot bottles, and hot air, to a man who is not inhaling a due amount of oxygen, as to attempt the same process on a marble statue. In a word, external heat is useful only in preventing the too rapid radiation of animal heat from the surface of the animal body. Alone, it can not supply heat; but, when a wholesome air is inspired, it can secure the retention of the heat that is developed in the animal furnace.

I spoke a moment ago of the open fire-grate. This is an essential for the room of the consumptive. Stoves of all kinds, heated pipes, and, in a word, all modes of supplying artificial warmth, except that by the radiation from an open fire, are, according to the facts which I have been able to collect, injurious. They are injurious because by their means the air is made too dry, an objection much less applicable to the open fire.

The symptom which I have most commonly seen elicited in the phthisical, by the inhalation of an unnaturally dry air, is hæmoptysis, a symptom brought on frequently by the constant cough which the dry air excites. This effect, in a minor degree, will, in fact, appear in some cases without any actual deposition of tubercular matter, under the influence of the same cause.

The temperature of the air in the room of the consumptive should be carefully watched by the patient himself. My friend Mr. Glaisher, than whom no one is more competent to speak on this point, recommends two thermometers, the one with a wetted bulb. By the use of these the humidity, as well as the temperature, can be regulated. This is most advantageous, and the sensations of a consumptive patient soon inform him what degree of moisture is comfortable and proper.

I have occasionally heard phthisical patients complain of the use of gas in the rooms where they are confined. Such complaints, however, have usually come from patients confined in workshops where the number of burners is very great, and where there is almost always some accidental escape of gas.

In private houses such objections are avoidable; but as the inhalation of coal-gas is injurious even in small quantities, and as the products of the combustion of the gas are also hurtful, the necessity of a free ventilation in rooms where it is burned, and in which consumptives are lodged, is the more urgent.

The care that should be taken to secure a good air in the living-rooms of the phthisical invalid must extend with equal care to the sleeping-apartment. This rule should always obtain when possible: *never permit one room to perform the two offices of bedroom and living-room.* The bedroom should be large, unencumbered by needless furniture, and thoroughly ventilated. If the temperature of the air without is not below 60° Fahr., the windows of the room should be boldly set open, and be kept open at the top all night. If they are to be closed of necessity, a free chimney-draught must be procured, and an Arnott's valve is always an advantage. The bed should be free of curtains, but a single screen may be placed so as to ward off any direct draught from the door or window. Warmth of body is best secured by woolen bedclothes; but, if the temperature of the air is below 60° Fahr., it will, with advantage, be raised to that pitch by a fire in the open grate. Gas should on no pretense be burned through the night in this bedroom, and as few other lights as possible, for the patient requires all the air that is to be had, and must not be carelessly robbed of it. Above all things, the consumptive person should be the sole occupant of his own bed and bedroom. To place such a one for several hours close to another person, however healthy, is injurious to both, but especially to the sick. No ties of relationship, and no mistaken kindness, should cause this rule of isolation ever to be broken.

It has been stated already that the room of the sufferer should be large. It should include, whenever practicable, at least fifteen hundred cubic feet of breathing-space, under all plans of ventilation. If more space can be had, all the better. If less only is obtainable, then the ventilation must be the more carefully attended to.

When the patient has left his room in the morning—and he should do so early—the windows and doors should be set open, and a current of air be allowed to flow through it during the whole of the day. If the air of the apartment be at a temperature below 60° Fahr., or loaded with moisture, the fire should be lighted two hours before bedtime.

Consumptive patients frequently ask, especially in winter-time, the value of what are called respirators; and I have known some poor people purchase things of this description at what was to them considerable cost. The use of mufflers, which are, in fact, respirators, has been known for ages; and Dr. Hales, more than a century ago, recommended a scientifically made muffler for persons obliged to enter into places where noxious gases were given off. Dr. Beddoes, too, as Dr. Arnott shows, pointed out, in the year 1802, that a few folds of gauze held over the mouth and nose made the air warm and moist for respiration, and that such mufflers were, therefore, useful to consumptive and asthmatic persons. The object of the muffler or respirator is this: it retains the heat thrown out in the expired air, and gives up this heat to the cold air that enters in inspiration. In cold, dry weather, the muffler is very useful, and should be worn by all phthisical patients when out-of-doors; but when the air is moist and cold it sometimes is complained of as embarrassing the respiration. It should then be thrown aside. Any patient may easily make one of these mufflers for himself, for the cost of a few pence, out of a piece of fine wire gauze, cut oval so as to cover the mouth and nose and fixed in the center of a small Shetland shawl, so that it may be tied on like an ordinary comforter, with the gauze in the center for breathing through. The metal gauze, plated or silvered to prevent rust, will last for several months, and in summer-time can be removed from the shawl and laid aside; but the shawl is often useful in all seasons.

Rule II. *Active Exercise is an Essential Element in the Treatment of Consumptives.*—The conditions for obtaining a due supply of air imply in some measure the necessity for exercise. But there are varieties of exercise. Drs. Rush, Jackson, and Parrish, are in favor of riding on horseback, but this is a thing not practically to be carried out in the majority of cases, and, as I think, not absolutely necessary. Walking is the more natural exercise; it brings into movement every part of the body, more or less, and, leading to brisker circulation in every part, causes a more active nutrition generally. Of late years I have very much recommended tricycling to consumptive patients, and often with great benefit. In many instances it is better than walking exercise, giving more perfect change of air and scene with less fatigue.

The extent to which exercise should be carried will vary with the stage of the disease, and temporary accidents—such, for instance, as an attack of hæmoptysis—may, for the moment, stop it altogether. But, when exercise is advisable, the general rule is to recommend that it be carried out systematically, cautiously, and courageously, and that each exercise should be continued until a gentle feeling of fatigue is felt through the whole muscular system. Violent and unequal exertion of the upper muscles of the body is unadvisable. When restored from the fatigue of one exercise, another should be undertaken, and during the day this can not be too often repeated. If the day be wet, then the exercise should be effected by walking in a large room, or by engaging in some game, such as skittles, billiards, or tennis.

If, in his waking hours, the consumptive patient can keep himself occupied pretty freely in muscular labor, he secures the best sudorific for his sleeping hours that can possibly be supplied; for as the force of life is always expended in producing motion or action, so, to use the words of Dr. Metcalfe, "the proximate cause of sleep is an expenditure of the substance and vital energy of the brain, nerves, and voluntary muscles, beyond what they receive when awake; and the specific office of sleep is the restoration of what has been wasted by exercise." Cough is very much less frequent in the course of the night in him who has been subjected to exercise in the day; while sleep, when it falls, is more profound, more prolonged, and more refreshing.

In summer-time, when the temperature of the day is high, the morning and the evening time are the best adapted for the periods of out-door exertion. In the other seasons, midday is preferable, as a general rule.

I have been asked, often, whether dancing is good exercise for children and young persons of a consumptive taint. There can be no doubt that it is so when properly conducted. When dancing is carried on, however, it must be done in a very large room, freely ventilated, and scrupulously free from dust; for, the more exercise the body takes, the more air it requires, and the less of incumbrances in the way of mechanical obstacles to a free respiration. In damp days, when walking out-of-doors is impossible, the consumptive child may thus have three hours' dancing with advantage; not in stuck-up bowing and scraping, finnicking, polite quadrillism, but in good active dances, that make every limb feel pleasant fatigue.

In the performance of muscular exercise let the consumptive never encumber himself, nor check the free movements of his body, by strappings, loads of clothes, carrying of weights, and the like. These are but tasks; they lead to unequal exertion in special sets of muscles, and to an inequality of expenditure of power which ought to be avoided.

A last consideration on the value of muscular exercise is, that it is eminently useful in keeping the respiratory muscles in a state of active nutrition. For, if to the loss of capaciousness in the lungs to receive air there is added a daily increasing failure in the muscles by which the acts of inspiration and expiration are carried on, it is clear that a double evil is at work. Now, this double evil is most actively presented in consumption. As the respiratory muscles, together with the other muscles, lose their tone, so do the general symptoms of exhaustion increase in severity, sometimes without very marked change in the pathological condition of the lungs. In sequence, day by day, as the nutrition of these muscles decreases, and as they fail in tonic contractile power, they gain in excitability; so that the irregular spasmodic contractions to which they are subjected in the act of coughing are produced by the merest excitement, and the cough is more frequent as it becomes more feeble.

RULE III. *A Uniform Climate is an Important Element in the Treatment of Consumptives.*—Consumptive patients are constantly asking questions as to the value of a change of climate. The poorest applicants for relief are anxious on this point, and are often ready at once to contemplate emigration, if the merest hope is given to them that such a course would prove beneficial. In considering climate, the fact should be remembered that the main point to be obtained is to select such a part of the earth's surface as presents the nearest approach to an *equality* of temperature. Different writers of eminence have given the most contrary opinions on climate and consumption. Some have recommended a warm climate, others the polar regions. Both parties have spoken from experience, and they are, in some measure, both right; for a climate equally cold and a climate equally hot are each much more favorable than one in which there are constant variations, and where the thermometer in the course of the year ranges many degrees from freezing-point up to 100° Fahr. or higher. Speaking of 153,098 deaths from consumption occurring between the years 1841 and 1851, the Irish Census Commissioners observe:

"As might naturally be expected, the seasons exercised a very marked influence upon the deaths from consumption. During the mild months of autumn, succeeding the warm season of summer, the deaths attributed to consumption amounted to only 23,010; with the cold of winter the mortality from this cause increased, so as to present a return of 38,956; but with the harsh, trying weather of spring it rose to 51,334, and in summer fell again to 39,798."

This statement represents a very important truth. It is certainly best for the patient if the temperature, while equal, be also temperate; but a mean temperature of 35° on one side, or 75° on the other, is preferable to one varying constantly, to-day at 60° Fahr., to-morrow at 40°, and a few days later at 80°.

From the experience gained in taking charge of a large number of consumptive patients it becomes a remarkable and highly-instructive task to learn the influence of climatic changes on the symptoms of the disease. I can usually predict, almost with certainty, the history I am to hear from the consumptives who are coming before me. If for some days there has been uniformity of temperature, and the weather has been mild and dry, so that an airing each day out-of-doors has been effected, the visit is quite a cheery one; all seems better; the medicines are said to agree. The cough is less troublesome, the body is warmer, and hope, diffusing an inward sunshine, lights up each face with brightness and activity. In frosty days, too, when the air is dry and the temperature continues even, the symptoms are often equally favorable; but during periods, so common in this country in the spring and in the beginning of winter, when the atmospheric variations are sudden, marked, and often repeated in the course of a few weeks, the general aspect of affairs is widely different. I have heard on these occasions almost every patient complaining; the symptoms are all exaggerated, the mind discontented. There is a general request for a change in the medicine. Something is asked for that will soothe, for the nights are passed indifferently. It is useless to comply always with these demands, since the exaggerated train of complaints has a general and common cause; but now and then the modification of symptoms is so great as to call for a modification of treatment. During these variations of season, deaths from consumption are most prevalent.

Thus an equable temperature is of great moment, and should always be sought after by the phthisical sufferer. If he can not remove from his own locality, and if the variations in it are considerable, he must take the best precautions at his command. In-doors it is not difficult to sustain a pretty even temperature, varying from 55° to 60° Fahr. Out-of-doors, something must be done by attention to clothing, and by the use of the respirator. The most marked variations, however, occur in the night, and hence the importance of keeping up an equality of warmth in the bedroom, in the manner already described.

The reasons why consumptives feel the effects of climatic changes so much are sufficiently obvious. The effects of such variations are felt, indeed, in the best health; for the body is in some measure both a barometer and a thermometer; at all events, it is subject to the same influences, the lungs being in all cases the parts most affected. With the temperature moderately high and the air dry, the physiology of respiration is carried on easily and well. The amount of oxygen taken in is ample; the expiration of water, carbonic acid, and ammonia is free; the pulmonic circuit of the blood is unimpeded; the exhalation of water from the skin is unchecked; and the radiation of heat from the body is moderate. Let these atmospheric conditions suddenly change for those in which the temperature is 35° Fahr., or less, and in which the air is charged with watery vapor, and the conditions of life are materially modified. The supply of oxygen taken into the lungs is less; the process of absorption of such oxygen by the blood is less; the expired products are lessened; the pulmonic circulation is impeded; the watery exhalation from the skin is, in part, suppressed; the radiation of heat from the body is much more rapid; and, as a result of all, the whole man, body and mind, is enfeebled in force and in vitality. This is the course of things in a healthy man during atmospheric variations. It is left with the reader to trace out the exaggerated evil of these changes in those who, at the most favorable times, are existing with the lungs reduced in capaciousness and the respiratory muscles in power.

I shall recommend no particular place as a resort for consumptives; for I wish not to enter into disputation on this point. But here is the formula for an hypothetical Atlantis for consumptives: It should be near the sea-coast, and sheltered from easterly winds; the soil should be dry; the drinking-water pure; the mean temperature about 60°, with a range of not more than ten or fifteen degrees on either side. It is not easy to fix any degree of humidity; but extremes of dryness or of moisture are alike injurious. It is of importance in selecting a locality that the scenery should be enticing, so that the patient may be the more encouraged to spend his time out-of-doors in walking or riding exercise. A town where the residences are isolated and scattered about, and where drainage and cleanliness are attended to, is much preferable to one where the houses are closely packed, however small its population may be.

In speaking thus of the value of an equal climate, I am guided chiefly by the facts daily presented to me in relation to climatic variations on patients living in these islands. Some authors, however, infer from mortality returns, gathered from various quarters of the world, that variations of climate do not materially affect the disease, but that it is uniformly more fatal in cities than in the country. In England the excess in cities is equal to twenty-five per cent.

The facts are not opposed to the value of climatic uniformity. On the contrary, they prove the value; for as consumption is most rare in extreme northern climates, and at great elevations, so in these localities are variations of climate less marked. It remains yet for statistics to show whether in the most favored patches of earth, where, with the absence of climatic variations, there is a genial but temperate warmth, the disease is less prominent and less fatal.

Rule IV. *The Dress of the Consumptive Patient should be adapted to equalize the Temperature of the Body, and so loose that it interferes in no way with the Animal Functions.*—Instinctive sensations both in health and disease naturally dictate the above rule. But it is too commonly the fact that these sometimes are disobeyed. Some persons think it a hardy, and therefore a beneficial, plan to dress lightly in all weathers. Foolish mothers send out their children in mid-winter with bare legs and chests; young ladies go to balls and evening parties with the upper part of their light dresses open over the throat and bosom. Others go on a different tack; they must at all seasons be smothered up in flannels and outer dresses, layer upon layer, carrying with the severest fatigue as much weight of cloth as they possibly can. Such persons on both sides evidently misunderstand the uses of clothes, or think them only ornamental appendages. Clothes are useful, in a sanitary point of view, simply as equalizers of temperature. Heat is transmitted slowly through flannel, so flannel is warm. For this reason, flannel which should be worn in winter is unnecessary in summer, unless it is of light and porous structure.

I speak here of the body in health. In the consumptive patient, the principle is modified. He, from the deficient play of his lungs, is virtually always living in winter; and we may find him on the hottest days breathing with anxiety, and with his hands and feet and brow cold.

For the consumptive, therefore, flannel clothing is always required, and it should cover the whole of the body. The thickness of flannel must vary according to the sensations; as far as is possible, the feeling of absolute cold ought to be at all times prevented. The consumptive should sleep also in flannel; not in the dress worn during the day, but in a flannel gown. The shoes worn should be lined with flannel.

A common practice in the selection of clothes is to imagine that the weight of a garment conveys an idea of its warmth-sustaining power. This is an absurd error, and for consumptive persons this mistake about heavy clothing must be carefully avoided. They may safely trust to flannel of so porous a texture that it can be breathed through without offering any appreciable obstacle to the breath, and they may then walk out as warm as they can be made by clothing, without the risk of being wearied from the burden beyond their powers of endurance.

All absurdities in the way of hare-skins, warm plasters, and the like, placed specially on the chest, are useless; and the plaster is worse than useless, since it checks the functions of the skin over a considerable surface, and is soon dirty.

There is one modern article of attire on which a word of caution must be said, because its bad effects are unmistakable. I must warn all, but the consumptive in particular, against wearing what are called water-proof India-rubber coats. The healthy man may tolerate one of these garments; the consumptive, never. It loads the under-clothes with moisture; it gives a cold envelope to the surface; it produces chill; and, by checking the cutaneous function, it throws a double amount of work on lungs already failing under their ordinary duties.

Is it necessary to more than condemn those abominations of female attire, corsets? I hope not. But not less injurious than the corset is the practice of placing a strap or belt round the waist, tightly buckled. In the old times, the ascetics wore the tight strap as a penance for sin. This was surely the true and original function of the article. Now it is a penance worn for society in a foolish mood.

RULE V. *The Hours of Rest of the Consumptive Patient should be regulated mainly by the Absence of the Sun.*—If exercise is important to the consumptive patient during the day, a due allowance of sleep is equally necessary during the night. The natural hours of sleep are from sunset to sunrise, and it is the business of the consumptive to make Nature his oracle. Shakespeare has happily said that sleep is the "chief nourisher of life's feast," and Menander held that it was "a remedy for every curable disease." The great use of sleep truly is to renovate; for in the sleeping state the formative processes go on most actively. Metcalfe has well defined the difference between exercise and sleep by saying that "during exercise the expenditure of the body exceeds the income; whereas during sleep the income exceeds the expenditure."

It is obvious that to the consumptive person nothing can be more important than that the income should alternately and at natural seasons exceed the expenditure; and it is quite remarkable how much alleviated all the symptoms of consumption are when sleep is insured. The rule I have laid down regarding the hours for sleep is imperative for many reasons: First, because in all seasons the actual amount of rest required by the natural man is pointed out by the course of the sun. Second, because to extend the day by artificial lights, making a little sun out of a gas-lamp or candle, is to feed that lamp with a part of the breathing store of the air, and vitiate the atmosphere. Third, because, though artificial light is injurious, the pure sunlight is, on the contrary, of the greatest worth in the acts of vitality.

Thus, to fulfill the natural law regulating the times of sleep, to escape from the artificial light, and to obtain the advantage of all the sunlight that can be secured, the consumptive patient should make the sun his fellow-workman.

As soon as the patient has risen, he should at once leave his bedroom; and, if the morning be fine, he should go into the open air. On this point Mr. Bodington, in a short essay "On the Treatment and Cure of Pulmonary Consumption," published in 1840, dwells with great force. "The profuse nocturnal perspirations are soon subdued," says Mr. Bodington, "by this method of treatment, and the debility they occasion avoided. The skin assumes a healthier action in proportion to the extent of exposure to the external atmosphere, particularly to the morning air."

In large towns the practicability of this last suggestion is less than in the country; but, even in London life, an early morning walk should be made a matter of strict business by the consumptive. On a fine summer morning, between four and five o'clock, a walk through the streets and squares of London is, indeed, a treat which few Londoners understand. The air is free of smoke; the thoroughfares are royal unimpeded highways; and, while the great population sleeps, the magnitude of its residence is best seen and understood.

Rule VI. *The Occupation of the Consumptive Patient should be suspended if it is in-door or sedentary; but a certain Amount of Out-door Occupation may be advantageous.*—This rule is often difficult to carry out. At the same time it is second to none in importance, as there is, in a word, no exciting cause of consumption so general as in-door occupation. I remarked that about two out of every three patients with consumption, who presented themselves before me at the Royal Infirmary, were employed in some in-door business. This was confirmed accurately by reference to the Infirmary books, the figures of which were very carefully analyzed for me by Mr. Pring, a student and assistant at the institution.

Out of five hundred and fifteen cases of consumption, not less than 68·34 per cent, or rather more than two thirds, were persons following in-door occupations. Possibly the percentage was even higher, for all who called themselves laborers were presumed to be out-door workers. Among the in-door occupations which presented the largest number of cases in this list, boot- and shoe-makers ranked first; needlewomen, second; watch- and clock-makers, third; domestic servants, fourth; painters, fifth; tailors, sixth; printers, of whom the majority were compositors, seventh; bookbinders, eighth; French polishers, ninth; cigar-makers, tenth; writers, eleventh; smiths, twelfth; tinmen, thirteenth; and cabinet-makers, fourteenth. There were, altogether, in the list one hundred and forty trades specified, but the above-named fourteen yielded rather more than forty-four and a half per cent of the whole.

In the case of parents having children of a consumptive tendency, the greatest care should be taken to obtain for them out-door employment. But here a serious delusion commonly comes into play. If the child is weakly, the anxious parent urges that it is unfit for hard labor and for out-door vicissitudes; so it is sent to a place where it will not be exposed to cold or hard muscular work, like a draper's shop, or to some occupation of an in-door character. By this grand, ignorant, and fatal mistake, many victims are added to the list of the phthisical class of the community.

In many in-door occupations a double mischief is at work. The patient is not only confined in an impure air, but is made also to inhale some foreign agent, present of necessity from the character of his work, and with which the air is charged.

Some sedentary occupations beget a habit of muscular inactivity. Unworked machinery always resumes work lazily, and muscles long left to a passive nutrition respond slowly to the dictation of the will. The physical inertia conquers the mental powers. Hence some patients can not be persuaded to give up their inactive pursuits, even when they have the opportunity. To prescribe to these individuals a walk of two miles a day is felt as a cruelty. Nor are these difficulties met with only in anæmic young girls, bleaching in millinery establishments, or in no establishments at all. They extend to men of various sorts: to men of letters, to men given up to sheer indolence, and to sedentary workmen, such as watch-makers, shoe-makers, and tailors.

On the other side, almost all occupations implying muscular exertion out-of-doors, without undue exposure to wet and damp, may be pursued by the consumptive as long as possible, and with advantage. Work keeps the mind occupied and in healthful tune.

I remember a patient once who, in the first stage of consumption, insisted on coming into town each morning from a considerable distance in the country, to look after his business, and to return home again in the afternoon. It mattered not that the sky looked threatening, for he was not afraid of such a trifle, although he thoroughly knew his critical condition. When expostulated with by his advisers (and, I am ashamed to say, by myself, for I was ignorant then of the truths I now state), his reply was: "My brothers and sisters have all died of consumption; they were coddled up, nursed, carried about, confined to bed, and bound in the cords of helplessness by the kindest hands, to the satisfaction of the doctor and of all concerned. But they soon died. I inherit the proclivity to the same disease, and I too shall die; I know it; but my course is different, for I have made up my mind to die in harness; I have kept at my business in resistance to all entreaties, and I am the only one of the family left." The plan adopted by this man was right; he bore the brunt of the disease for months, and is alive and occupied still.

I recommend all in whom consumption is hereditary, whose occupation is in the open air, to take to heart the motto of this man, to make up their minds "to die in harness." They will live the longer for the resolution.

At the same time, as there is a medium in all things, so is there in work and exercise. Excessive and violent muscular fatigue is next door in injuriousness to complete muscular inactivity; and it is remarkable, in looking over tables of the occupations of consumptives, to find that, among those who are reported to have been occupied in out-door work, the majority have belonged to pursuits which imply an *extraordinary* muscular expenditure.

RULE VII. *Excessive Mental Exertion should be avoided by the Consumptive.*—It is the fate of some members of the human family, who are of consumptive taint, to have minds of a very active and laborious character. As children, these love reading, and pursuits of an intellectual kind. They are specially precocious; and admiring parents, with proud hopes as to the future of their offspring, encourage an exertion which ought ever to be kept in bounds. As these precocities grow up, their mental development runs out of proportion to the development of the body. On this, muscular labor becomes a bore, and the study or desk the only enjoyable place in life. The result is, not that the mind by its overwork directly wears out the body, but that the body is neglected, and its physical degeneration hastened.

The bad effects show themselves first, according to my observation, in derangement of the digestive system. In young persons of consumptive taint, the impaired nutrition of the whole body, incident to the impaired digestion and broken sleep, tells speedily on the respiration, and supplies the first link in the fatal disease. Let all the absurd poetry about "those dying young whom the gods love" go its way. The gods love and help those who live naturally—and these die *old*.

I have seen so much mischief arise from the overwork of the mind, in consumptive children and youths, that I have dwelt no longer than is really necessary in treating on the importance of the present rule. If I had a child of decidedly consumptive tendency, he should scarcely touch books at all. He should be taught orally as much as possible; he should be brought up in the open air, and to out-door sports and occupations; and he should be encouraged to enter into every innocent game where the muscles are brought into vigorous play.

The choice of an occupation is best made by adopting the exclusion process. Exclude every calling in which close confinement to the study, the shop, the counting-house, or any other house, absorbs the greater part of life. The agricultural life is, on the whole, the best.

Every occupation will be modified with advantage by the enjoyment of ennobling pleasures. The dance, the lecture, the drama, music, is each good in its season, when attainable without injury to health. But from all crowded assemblies I warn the consumptive to keep away. The pleasure derived from them is nothing in comparison to the evil insured in obtaining it.

Music has a grand influence on some minds, and may be cultivated with advantage under due regulations; but upon wind-instruments the phthisical man should not exert his skill. The exertion of blowing these instruments interferes materially with the regular play of the respiration and circulation. In playing upon stringed instruments, moreover, the amusement should not be carried on until it wearies the performer. Mothers anxious for the accomplishments of their daughters make frequently a fatal mistake on this score. They place a poor child, who has no musical tastes, at the piano-forte ; and there she is made to sit hour after hour, until a lesson is perforce learned, or an exercise completed. The system, useless in an educational sense, is fraught with direct danger to health.

For the consumptive, reading aloud is a good daily practice. Cuvier, the great naturalist, attributed his recovery from threatened phthisis to the delivery of some lectures which he was appointed to give. There should, of course, be a limit to the time of reading aloud ; it should never exceed an hour, should be stopped if hoarseness or weariness occur, and should be without effort or vociferation.

The selection of books for the entertainment of the mind is a further and important point. Exciting romances, filled with the narrations of deep and fiendish plots or hyper-poetic sentiments, are quite out of place, for they, through the mind, influence respiration to the detriment of the physical forces of life. So also do dull, monotonous, whining, terror-striking treatises, of whatever kind. But the book which is amusing, and which, with easy effort, raises the hearty laugh at an innocent picture, or the book which carries the reader along the page of history with gentle carriage, or tells of natural facts in natural language—this is the book to be sought for.

Singing is an amusement which may with prudence be followed by the consumptive in whom the tendency to the disease is indicated only, and the disease itself is not actually developed. The exertion must not, however, be kept up so long at any given time as to produce breathlessness or hoarseness. It must be done without labor or distress, and at intervals when the body is in a condition to sustain the effort. It is then useful.

To sum up, the amusements of the consumptive should combine with the pleasure they afford a moderate and equal degree of muscular exercise, and with the muscular exercise a degree of exhilarating amusement free from over-excitement and mental toil.

Rule VIII. *Cleanliness of Body is a Special Point in the Treatment of Consumption.*—But little need be said to enforce this rule. In health there is always a mutual understanding and a kind of partnership between the skin and lungs. In consumption moderate action of the skin is a relief to the lungs, and as such ought to be encouraged. This is best attained by keeping the skin clean by daily ablution. Let the consumptive boldly take his bath as each morning comes ; not a shower-bath, not a cold bath, under any impression that water cast on the body in a certain fashion, or at a certain temperature, will give strength, but a tepid cleansing bath, with the temperature from five to ten degrees below that of the body. There is no occasion to stay in the bath a moment longer than to obtain a free ablution; then the patient should rapidly but effectually dry himself all over with a rough towel, and dress with the flannel garment undermost.

The clothes of the patient should be scrupulously clean; the under-clothing should be changed every day.

Rule IX. *Abstinence from all Habits of Gross Sensual Indulgence is an Essential Part both in the Prevention and the Cure of Consumption.*—I need not particularize the vicious sensual indulgences to which many of human-kind habituate themselves; for as suggestive descriptions are better left unwritten for those who are ignorant of sensual indulgences, so for those who require to be forewarned no such descriptions are demanded, since they know too much already. In a word, I should say that, the grosser the sensuality indulged in, the greater is the physical evil resulting from it. Let the consumptive, at least, bethink themselves what vices affect and prostrate most, and then with strong mind and will give them up altogether.

To those who have charge of the young, no duty is so imperative as that of carefully watching over the physical interests. Let these make it their first care to prevent the tendency to sensual debasement. In large schools, a little attention and firmness on the part of teachers and governors, with the assistance of medical supervision, would obviate a host of life-long evils.

Rule X. *The Diet of Consumptive Patients should be ample, and should contain a Larger Proportion of the Respiratory Constituents of Food than is required in Health.*—The appetite of consumptive patients is very capricious, and daily grows more so if it be not sharpened up by exercise. When the food taken is not applied to the purposes of nutrition, it is better left untasted; for otherwise it lies undigested in the alimentary canal, and sets up a serious train of dyspeptic symptoms, nausea, and diarrhœa. Kind friends often, with the most provoking and mistaken good-nature, thrust upon the consumptive relays of the most improper food, because the necessity for nourishment is so obvious. But the fact is that, when the lungs are acting indifferently, digestion can not go on actively, since, as Arbuthnot well observed, respiration is "the second digestion." Hence the quantity of food taken by the consumptive person should be small at each meal; but the meals may, if the sensations of the patient require it, be more frequent than in health. Of animal foods, mutton is the best. Fatty and oily foods, which constitute the respiratory class, should predominate, and fresh butter, with bread, may be taken almost *ad libitum*, so long as it agrees with the stomach. Cream, too, is excellent, and the luxury of curds and cream is very suitable. Milk, whenever it suits, is advisable as a constant drink-food, and good cows' milk, new, answers every purpose. There are, as far as I can gather from numerous cases in which I have seen them tried, no such specific virtues in asses' milk and goats' milk as some have supposed. Tea may be taken, in moderation, with perfect safety. Fresh vegetable diets should not be omitted; and fruits, especially roasted apples, are always admissible, except in instances where they excite irregular action of the bowels. The Iceland moss has had a great reputation, as have jellies of different kinds, but these often are slow in digestion, and they have no specific value.

The question of the use of alcohol in consumption is one on which scientific opinion is much divided. I have recommended alcohol under some conditions of the disease, and I have shown, on the other hand, that one particular kind of consumption may be produced by indulgence in alcohol. Of late years I have prescribed alcohol very sparingly, and never in the form of the pernicious mixtures in which it is sold for general use under the names and forms of alcoholic beverages. When I now prescribe it, it is purely as a medicine and in the form of alcohol itself properly measured, properly diluted, and properly timed. In this form it comes under the head of medicinal, as distinguished from hygienic, treatment, and, I am satisfied, with much more value than when it is inaccurately classified as a food or drink.

The two indulgences, snuff-taking and tobacco-smoking, ought to be strictly avoided by the consumptive.

Reviewing what has been thus written, I would add, as a supplement to the ten rules submitted, that, whenever distinct evidences of phthisis have set in in an individual of either sex, the marriage of such person is wrong, if not inexcusable; while the marriage of two persons, both the victims of the disease, is opposed both to reason and humanity.

Concluding Note.—The above essay "On the Hygienic Treatment of Pulmonary Consumption"—less one or two minor revisions—was written and published under the same title in 1856.

The essay found little favor. It was considered as not practical, and as conveying the ideas of a dreamer, that the fatal disease, consumption, could be prevented generally, and treated specially by hygienic measures. To-day, under a revival of the old animalcular speculation as to the origin of some diseases from living forms—the entity doctrine in a new dress—the conception of the hygienic treatment of pulmonary consumption has been accepted in name as well as practice, as if it were new in word and in deed, the height of practical learning and skill. So ideas change; and the disfavored of one generation is the favored of another. But it matters not how or by whom it is borne, so long as the torchlight of truth makes its way.—*The Asclepiod.*

TRADE DISTINCTIONS IN ALCOHOLIC LIQUORS.

By W. E. BRADLEY.

THE answer given by Mr. Dawson to the question, "Can pure, unadulterated alcoholic liquors be now obtained?" supposed to be vicariously asked by an inquiring public in his article, "How Alcoholic Liquors are made," in the May issue of "The Popular Science Monthly," would have been entirely correct if it had ended with a simple affirmation. As it stands, however, it is grossly misleading, inasmuch as it confounds substances possessing essentially different characteristics, which are universally recognized commercially by distinctive nomenclatures, and under the United States internal revenue system are controlled by different laws and regulations.

After giving a brief outline of the processes of mashing, fermentation, and distillation, which is in the main correct so far as it goes, Mr. Dawson says: "The process of rectification is generally done by redistilling, or filtering through alternate layers of woolen blankets, sand,. and granulated charcoal, . . . after which process a little burnt sugar is added to give them a kind of straw-color, simply, I presume, to distinguish them from water. . . . After rectification, the spirits are gauged by the United States gauger, and a rectifier's stamp is placed upon each package, and the whisky is then ready for market, pure and unadulterated, and known as one-stamp goods. Remember that I am now stating how *good* whisky is made. . . . Therefore, if you want a pure article, purchase from a distiller or first class reliable dealer. . . . Insist that the spirit must be at least twelve months old." Merely remarking that spirits to which burnt sugar has been added would not ordinarily be called pure and unadulterated, or the addition be considered necessary to distinguish between two such dissimilar substances as alcoholic spirit and water, I make the unqualified assertion that what is above described as good whisky is not whisky at all, and never can be. This will become plain upon a consideration of some of the distinctive details in the production of rectified spirit and whisky, by which it will appear that, although the molecular changes by which starch is converted into glucose, and glucose into spirit, are the same in both cases, the subsequent treatment differs widely, with a corresponding dissimilarity in the finished product.

It is well known that in the chemical transformations which take place during alcoholic fermentation, besides ethyl or ordinary alcohol, which is the chief remaining product, certain other substances are generated which are collectively known as fusel-oil, and which may be defined as "those products of alcoholic fermentation which distill at a higher temperature than ethyl alcohol" (173° Fahr.). The principal of these is always amyl alcohol, which boils at 273° Fahr. Besides this there are butylic and propylic alcohols and volatile fatty acids, principally acetic, in variable but subordinate quantities. The fusel-oil has a pungent odor and burning taste, easily detected in the crude product of ordinary distillation. The object of the rectifier is to remove it entirely, and produce what is known commercially as "neutral" or "pure" spirit, his ideally perfect result being ethyl alcohol, chemically pure save for the water of association. It follows, therefore, that all rectified spirit being of the same character, and with a standard of quality, is a staple article of merchandise, and the great consideration with the manufacturer is to produce it with as little expense as possible, rectification being depended on to remove all offensive ingredients.

Damaged grain, which can be bought so cheaply that the low price will compensate for decreased yield and increased expense of handling, is as available as any other, provided that rectification will rectify the product. Even potatoes, which produce in fermentation such an excessive quantity of fusel-oil that amyl alcohol is commonly known as "potato-oil," are, on account of cheapness, extensively used in Germany, and so perfectly is the rectification conducted that the German pure or "Cologne" spirit is unsurpassed in quality.

When amylaceous material is boiled with a small proportion of a strong mineral acid, there results an almost perfect conversion of the starch into sugar. For this reason an attempt was made in this country several years ago, on a commercial scale, to dispense with the use of malt in the manufacture of rectified spirit by substituting sulphuric acid in the mash, and afterward neutralizing it before fermentation. Had the attempt been successful, it would, on account of the cheapness of the substitute, have caused a material reduction in the cost of the alcoholic product. It turned out, however, that the successful neutralization of the acid was difficult, and that the alcohol developed by the subsequent fermentation was so acted upon by it as to produce sulphuric ether, which, besides causing a waste of material, could not be removed economically; had this proved feasible, sulphuric acid would undoubtedly have come into general use in the manufacture of rectified spirit.

In every detail of the manufacture the same law of economy holds good; and that machinery is most popular which will accomplish the desired result with the least expenditure of time, material, fuel, and labor.

I mention these facts mainly to show that, however unpromising for a favorable result are the preliminary materials and means, rectification thoroughly conducted is relied upon as a practical remedy for all defects, and they no more detract from the character of the finished product than does the nature of its source from the purity of perfectly filtered water.

Pure or neutral spirit is largely used for the manufacture of counterfeit whisky, brandy, etc., in which the imitation is produced by the addition of foreign substances which must be used sparingly, both on account of economy, and because their character must not be too obtrusively shown. It is plain, therefore, that the more effectively the pungent fusel-oil is removed, the better the rectified spirit will be for the purpose, as any attempt to mask its odor and taste by an excess of the flavoring materials would betray the deception by the character of the resulting products. Mr. Dawson truly says that "compounding is diabolizing," but rectification is necessarily its preliminary step.

Besides the fusel-oil, rectification also removes the essential oils which may be contained in the alcoholic distillate, naturally giving it the characteristic flavor of the original grain, rye imparting a rye-flavor, corn a corn-flavor, etc. While there is nothing necessarily injurious in these essential oils, they would nevertheless be justly considered impurities where the object in view is the production of neutral spirit, and are naturally eliminated by the mechanical means employed for rectification.

Our finished product is now as complete as it ever can be, as ethyl alcohol possesses inherently no latent quality which can develop in it a more perfect character. Even if the unusual device is adopted of storing it in a charred-oak barrel (a treatment almost universal with whisky), the resulting color and astringency will add nothing to its value, but a marked and rapidly increasing shrinkage of volume will follow, without any compensating advantage. It behooves the owner, therefore, to market it as soon as possible, and it would certainly be some especial reason which could induce him to keep it on hand for even the shortest time (twelve months) which Mr. Dawson regards as necessary for its proper development. Rectified spirit, therefore, may be described as the purified product of crude alcoholic distillation (high-wines), and as close an approximation to pure ethyl alcohol and its water of association as the mechanical means available to the rectifier will produce.

The legal definition goes still further, and includes, in the words of the statute, "any spurious, imitation, or compound liquors" manufactured by mixing distilled spirits, wine, or other liquor, with any materials for sale under the name of whisky, brandy, rum, etc. All rectified and compounded goods put up in casks are, under Government regulations, stamped with one stamp only, and are known as "one-stamp" goods.

What, then, is whisky, and especially good whisky?

Its largest proportion is of course ethyl alcohol and water, with sufficient of the essential oil of the grain to give it its distinctive grain-flavor, although this is sometimes so feebly developed as to leave its character in doubt, and deteriorate from its market value, especially in the case of rye-whisky. When new, it also necessarily contains a small quantity of fusel-oil, and it is this complex substance which gives to whisky its distinctive character as compared with other alcoholic liquors, and, by the relative proportions of its component parts to each other and to the whole mass, eventually determines its quality. In view of the poisonous and deleterious character of fusel-oil, this statement may seem like a confirmation of the frequently expressed opinion that all whisky is essentially injurious in its physiological effect; and, indeed, the fact of its presence in immature whisky has been illogically used as one of the strongest reasons in favor of total abstinence. The argument, however, is no more consistent than would be the indiscriminate condemnation of all fruit because unripe fruit is unwholesome, and a large proportion of it never reaches maturity at all. For note the proviso, "when new." . . . Whisky, when first distilled, is entirely colorless, and, with a few local exceptions, is put up in charred white-oak barrels. The gradually deepening amber hue is imparted to it by the thin brown layer of baked wood underlying the charred surface, the charcoal itself—contrary to the general opinion—having no influence in this respect. No extraneous coloring-matter is needed, nor is any ever used by first-class distillers. A very little tannic acid is also extracted from the wood, causing a slight astringency in the liquor. By far the most important changes, however, are the chemical ones which take place in consequence of the presence of the fusel-oil, its constituent acids and alcohols acting and reacting upon each other with the production of fragrant ethers at the expense of the crude reagents, so that, in a perfectly ripened whisky, the fusel-oil should disappear, with the formation of acetate of amyl (pear-oil), butyric ether (pineapple essence), valerianate of amyl (apple-oil), œnanthic ether (Hungarian-wine oil), etc. Strange transformations these may seem at first sight; but, nevertheless, they are entirely in accordance with chemical analogy, and by no means so remarkable or complex as those by which the volatile alcohol is derived from the solid starch. The development of these fruit-essences is very slow, but may be somewhat hastened by good ventilation and the proper degree of natural heat. It is probable that there are also other subtile changes, the *rationale* of which has never been explained, but without which the result would be imperfect, as otherwise it would be fair to suppose that the same end could be attained by adding the proper fruit-essences to rectified spirit, whereas in fact the art of the compounder has never been able to produce a good commercial imitation of the genuine article.

The entire series of changes is called "aging," and to it is due the mellowness and aroma which characterize a well-ripened maturity. They can never take place in rectified spirit, as it does not contain the necessary constituents. The length of time during which good whisky will continue to improve can not be limited by any absolute number of years. It should, however, never be used when younger than from three to five years; six years old is still better, and under wise Government regulations it might come about that the usual age will not be less than that.

Too much fusel-oil is even more destructive of quality than none at all, and produces a crudeness and roughness which no lapse of time can remove. There is plenty of whisky made with just these characteristics, but not even by courtesy can it be called good ; some of it, indeed, is so bad that, after a very limited time, it grows worse instead of better ; such a result can come only from the carelessness or incompetence of the manufacturer, or from lack of suitable apparatus.

The great aim of the intelligent distiller is, first, to prevent excessive development of fusel-oil ; and, secondly, to so arrange the details of his distillation that just the proper quantity shall appear in his distillate, and in the proper proportions. Theoretically its constituents should be possible of removal from the ethyl alcohol by ordinary distillation, in consequence of their higher boiling-points. In fact, however, certain portions are carried over mechanically at lower temperatures, and it is this fact which makes it possible, by the shape, arrangement, and manipulation of the distilling apparatus, to so control the process that, practically, none of the constituents of the fusel-oil shall be in injurious excess or deficiency, but all harmoniously proportioned to further the development of the aging-process. This partial control, however, does not relieve the fine-whisky distiller from the necessity of close attention to the preliminary steps. Good grain is absolutely necessary for the production of good whisky. Good water, scrupulous attention to cleanliness, and the most careful personal supervision, guided by long experience, are equally imperative ; for, unlike the rectifier, he has no universal remedy after distillation for all defects. His product, once imperfect, must either remain so, or, by rectification, lose its character altogether.

Mr. Dawson says, either directly or by implication, that most good whisky-distillers either rectify their product themselves or that it is done in a rectifying-house. Such a gross mistake could only come from want of discrimination between the distinctive characteristics of fine whisky and rectified spirit, the former being either excluded entirely from his consideration, or else confounded with the lower grade of goods. As a matter of fact, no fine whisky is ever rectified, and from the previous description it is easily seen why such treatment is not only unnecessary, but would be positively destructive to its proper development. Neither is it ever offered for sale as one-stamp goods ; why, will be easily understood when it is known that the best brands of fine whisky are worth, when new and in bond, from two to three times as much as one-stamp or rectified goods, the disparity in value increasing with age.

Explanation of the cause removes the mystery ; and to the judgment of the reader, in view of the facts set forth, I leave the consideration of the propriety of using one-stamp alcoholic spirit twelve months old.

THISTLES.

By GRANT ALLEN.

THERE is no weed weedier or more ubiquitous than the common thistle. In paradise, it is true, if we may trust John Milton and the Sunday-school books—wise, as usual, beyond what is written—there were no thorns or thistles ; the creation and introduction of the noxious tribe upon this once innocent and thornless earth being a direct consequence of the fall of man, and a stern retribution for Adam's delinquency. But since then the thistle has managed so to diffuse itself over the habitable globe that there hardly now remains a spot on earth without its own local representative of that ever-intrusive and conquering genus. Wherever civilized man goes, there the thistle accompanies him as a matter of course in his various wanderings. It adapts itself to all earthly environments. Close up to the Arctic Circle you find it defying the indigenous reindeer with its prickly wings ; under an equatorial sky you may observe it accommodating itself most complacently with a sardonic smile to tropical existence, and battling with the prickly cactuses and the thorny acacias, to the manner born, for its fair share of the dry and arid uplands. Even nettles are nowhere in competition with it ; in spite of its valuable and irritating sting, the nettle has not the plasticity and adaptability of constitution that mark the stout and sturdy thistle tribe. Garnered and harvested yearly with the farmer's corn, its seeds have been gratuitously distributed by its enemy, man, in all climates ; and, when once it gains the slightest foothold, its winged down enables it to diffuse itself *ad infinitum* through the virgin soil of yet unconquered and unthistly continents. A field of thistles in England itself is a beautiful sight for the enthusiastic botanist (who has usually a low opinion of the agricultural interest) ; but in the fresh and fallow earth of New Zealand they attain a yet more prodigious and portentous stature, that might well strike awe and dismay into the stout heart of a Berkshire farmer.

The fact is, the thistle is one of those bellicose plants which specially lay themselves out, in the struggle for existence, for the occupation of soils where they are compelled to defend their leaves and stems from the constant attacks of the larger herbivores. On open plains and wide steppes, much browsed over in the wild state by deer or buffalo, and in the degenerate civilized condition by more prosaic cows and donkeys, one may always note that only the prickliest and most defensive plants have any chance of gaining a livelihood. Gorse and blackthorn form the central core of the little bushy clumps on our English commons, grown over thickly with bramble and dog-rose, or interspersed every here and there with occasional taller masses of may and holly. Nay, at times even naturally undefended species assume a protective armor under such special circumstances, as in the case of the pretty little pink rest-harrow, which grows close to the ground with soft stems and leaves where unmolested by cattle, but quickly develops an erect and stiffly thorny variety when invaded by troops of cows or horses. In that case the unarmed specimens get eaten down in a short time by the browsing cattle, and only those which happen to possess any slight tendency in a prickly direction are left to occupy the stubborn soil and produce seed for the next generation. It is this unconscious selective action of the larger herbivores which has at last produced the general prickliness of all the plants that naturally frequent rich and open lowland pastures.

There are differences, however, between prickles and prickles. Some plants are positively aggressive, like the stinging-nettle; others are merely and strictly defensive, like the common thistle, whose proud motto, as everybody well knows, is "Nemo me impune lacessit." In the very doubtful Latinity of the Licensed Victualers, it goes in strictly for "Defensio non provocatio"; whereas the nettle, it need hardly be said, is often most distinctly provoking, and even goes out of its way to annoy a neighbor. This distinction I take to depend upon a difference in the acquired habits of the two races. The nettle is almost entirely a product of urban civilization; it hangs about the streets and out-houses of small villages, the neighborhood of farmyards, and the immediate surroundings of rural man. It lives in constant expectation, as it were, of being browsed upon by donkeys, or trampled under foot by cattle, or picked by children, or stubbed up root and all by the ruthless farmer. Hence its temper has become permanently soured, and it has at last developed a restless, feverish, wasplike habit of stinging everybody who comes within arm's length of it. It is necessary to the safety of the nettle, in fact, that it should give you warning of its presence at once, and induce you to keep well away from it under pain of a serious and lasting smart. Our common English nettle, which grows everywhere along road-sides and waste places, is bad enough in this respect; but the smaller nettle—a foreign importation of more strictly civilized and urban habits, never found far from human habitations—is still crueler and more poisonous; while the South European Roman nettle, accustomed for innumerable generations to the fierce struggle against Italian civilization, has developed an advanced and excruciating sting, which beats the puny efforts of our own species into complete insignificance, as the virus of the hornet beats the virus of the hive-bee.

On the other hand, the thistle family are far more truly rural and agricultural in their habits, being denizens of the open fields and meadows, less dependent than the nettles upon richness of soil, and readily accommodating themselves to all vacant situations. Hence they have only felt the need of arming themselves in a rough-and-ready prickly fashion against the probable assaults of their natural enemies. They have forged darts, but have not learned to poison them. Their prickly leaves and wings are amply sufficient for defense, without the necessity for developing a virulent juice to be injected into the very veins of their savage aggressors. Natural selection can never push any special line of evolution further than is imperatively called for by the wants and circumstances of the particular species. It always necessarily leaves off just at the point where the protection afforded is fully sufficient to guard the kind from the possibility of extinction. The thistles have found in actual practice that prickles alone are quite enough to secure their boasted immunity from extraneous attacks : the nettles have practically discovered for themselves that without stings they would soon be landed in the final limbo of utter nonentity.

Circumstances have still preserved for us a very tolerable series of the successive stages whereby our existing thistles have gradually acquired their present prickly and repellent characteristics. In the good old days, while evolution was still fighting hard for public recognition, it used to be urged by the uninstructed outsider that we never found any "missing links." As a matter of fact, in ninety-nine cases out of a hundred, the links are not and never were missing at all ; and the practical difficulty is rather to establish any well-marked distinctions of kind than to discover long series of intermediate individuals. Just as the white man gradually merges into the negro by slow steps, when we cross Europe, Asia, and Africa, through Italians, Greeks, Levantines, Arabs, Egyptians, Nubians, Abyssinians, and true Soudanese, so the various kinds of thistles merge imperceptibly one into the other by innumerable varieties and natural hybrids. To be sure, there *are* such things as well-marked species in nature ; but there are also groups which it is impossible anywhere to split up into good and distinctly different kinds. The brambles, the wild roses, the St. John's-worts, and the epilobes absolutely defy regular classification : the thistles, though perhaps a little more amenable to the subtile arts of the artificial species-maker, still constantly glide one into the other by strangely graduated intermediate forms. The great *crux* really lies in the problem of the existence of such natural gradations ; for, according to the strict Darwinian principles, the better adapted and more specialized forms ought to crush out the intermediate types, and leave the species well demarkated one from the other by broad intervals. Probably the true explanation of the anomaly is to be found in the wide distribution and high adaptability of these dominant forms ; they can accommodate themselves exactly to such an extraordinary variety and diversity of situations, that special intermediate types answer best in every intermediate soil or climate.

The most primitive and unarmed class of the thistle tribe is well represented by the saw-wort of our copses, a true thistly plant in all its general appearance and habits, but absolutely devoid of thorns or prickles. The leaves, indeed, are toothed and pointed, but the points never project into fierce spines, as in the more advanced kinds; and even the little scales that form a cup for the flower-head, though faintly stiff and sharp, are scarcely if at all defensive in character. The flower, of course, is usually the first part to be specially protected, because upon it depend the future seeds and the hope of coming generations of thistles. Just as instinct teaches female animals to fight fiercely and bravely for their young, so natural selection teaches menaced plants to arm themselves stoutly against the threatening depredators of their seeds and blossoms. The reason why the saw-wort and its unarmed South European allies have managed to do without the protective inventions of their more developed relations is no doubt because they live mostly in thickets and woody places, not much overrun by cattle or horses. Their neighbors in the open meadows and pastures have been compelled long since to adopt more military tactics in order to save themselves from premature extinction. Often, indeed, in a close-cropped paddock, you will find only two kinds of tall plant uneaten by the beasts—the meadow buttercup, preserved from harm by its acrid juices, and the creeping thistle, armed all round with its long rows of parallel prickles.

In the mountains of Wales and the north of England there is yet another kind of true thistle, classed as such by technical botanists (for the saw-wort is artificially relegated to a distinct genus), which is also destitute of prickles on the leaves, though it sometimes shows the first faint beginnings of a prickly tendency around the scaly flower-cup, and in the bristly teeth of its crinkled leaves. From this early stage in the evolution of thistledom we can trace the gradual steps in the defensive process, through thistles that grow with prickly leaves, and those in which the prickly margins begin to run a little down the stem, to those which have clad themselves from top to toe in a perfect mail of sharp spines, so that it becomes quite impossible to grasp them anywhere with the hand, and they can only be eradicated by the hoe or plow. It is a significant fact that the most persistent and troublesome of all these highly developed kinds, the creeping thistle, now universally diffused by man over the globe, is a special weed of cultivation, far most frequently found in tilled fields, and seldom disputing with the simpler forms the open moors, mountains, or pastures. It does not trust entirely, like others of its kind, to its floating seeds, blown about everywhere as they are by their light tag of thistle-down; but it creeps insidiously underground for many yards together, sending up from time to time its annual stems, and defying all the attempts of the agricultural interest to exterminate it bodily by violent measures. This is the common and familiar pale purplish thistle of our English corn-fields, and there can be little doubt that it has developed its curious underground habits by stress of constant human warfare, especially with the plowshare. Thus the very efforts we make at fighting Nature defeat themselves: if we persistently hoe down the stems and leaves of an obnoxious weed, the weed retaliates by sending out hidden subterranean suckers, and the last state of the agriculturist is worse than the first.

On the close-cropped chalk downs of our southern counties there is another curious form, the stemless thistle, which shows in another way the hard struggle of Nature to keep up appearances under the most difficult and apparently hopeless circumstances. Among the low sward of those chalky pastures, nibbled off incessantly as fast as it springs up by whole herds of Southdowns, no plant that normally raised its head an inch above the surface would have a chance of flowering without being eaten down at once by its ruthless enemies. So the local dwarf or stemless thistle has adopted a habit of expanding its very prickly leaves in a flat rosette or spreading tuft close to the ground, and bearing its blossoms on the level of the soil, pressed as tight as possible against the short turf beneath. The appearance of these three or four dwarfed and stunted but big flower-heads, bunched thickly together in the middle of their flat leaves, is most quaint and striking when once one's attention is called to their existence: yet so unobtrusive and unnoticeable is the entire plant that few people save regular botanists ever discover the very fact of its presence on the chalk downs. It is only one out of a large group of specialized chalk plants, all of which similarly creep close to the ground, while a few of them actually bury their own seeds in the soil by a corkscrew process, so as to escape the teeth of the all-devouring sheep. The power of producing a stem, however, is rather dormant than lost in the dwarf thistle, for under favorable circumstances and in deep soil it will raise its flowers eight or ten inches above the surrounding turf.

The question what particular plant ought to be identified with the stiff, heraldic Scotch thistle has long been debated, somewhat uselessly, it must be acknowledged, among botanists and antiquaries. For heraldry is not particular as to species and genus: it is amply satisfied with a general rough resemblance which would hardly suit the minute requirements of those microscopical observers who distinguish some forty kinds of native British blackberries. However, it has been amicably decided in the long run that the heraldic symbol of Scotland, that proud plant which no man injures unavenged, is not to be considered a thistle at all, but an onopord, a member of a neighboring though distinct genus, whose Greek name expressly marks it out as the favorite food of—how shall I put it with becoming dignity?—the domestic beast of Oriental monarchs. To what base uses may we come at last! The royal emblem of the north, as identified by Mr. Bentham and other profound authorities, is now at last settled to be nothing more nor less than the cottony donkey-thistle. North of the Tweed this identification should be mentioned, as French newspapers remark, under all reserves.

Almost all the thistles have purple florets, and purple, it may be safely assumed, is the primitive color of the whole thistle-head tribe. Some of them, indeed, fade off gradually into pink and white; but such reversion to a still earlier ancestral hue is everywhere common and easily brought about by stress of circumstances. The thistles in the lump are composites by family, and the apparent flower is really a flower-head, containing an immense number of small, bell-shaped, five-petaled florets, with the petals united at their base into a deep tube. The honey rises high in the throat within, and is sucked chiefly by bees and burnet-moths, who form the principal fertilizers of the entire group. Purple is the favorite color of these advanced flower-haunters, and it seems probable that all the purple blossoms in nature have been evolved by their constant and long-extended selective action. Nothing can be more interesting than to watch a great burly humble-bee (one of the large black sort) bustling about from flower-head to flower-head of the pretty, drooping, welted thistle on a bright summer's day, with his proboscis constantly extended in search of food, and unconsciously carrying the pollen-grains about his head and legs from the florets of one blossom to the sensitive surface of the next in order.

After the flowers have been duly fertilized, the thistle-seeds begin to swell, and the down around them to grow dry and feathery. This down, so familiar to all of us among the autumn fields, has doubtless played no small part in the dispersal of the thistles. It is to their floating seeds (or rather, to be strictly accurate, their fruits) that the entire family owe a great part of their existing vogue and unpopularity. In almost all the composites the tiny calyx grows out into much the same silky down on the ripe fruit, but in hardly any other case, save perhaps those of the dandelion and the common sow-thistle, does it form so light and airy a floating apparatus as in the true thistles. Wafted about on the wings of the wind, the thistle-down is blown easily hither and thither, alighting everywhere, far and near, and finding out fresh spots for itself to root and thrive on every side. Not only does this plan insure the proper dispersal of the seeds, however: it also provides for that most important agricultural need, the rotation of crops. Long before scientific farming had hit upon the now familiar rotatory principle, hundreds and hundreds of plants in the wild state had worked it out practically for themselves under stress of the potent modifying agency of natural selection. For thistles can no more grow on the same spot for an indefinite number of generations than corn or turnips can; they require to let the soil on which they live lie fallow for a while from time to time, or be occupied by other and less exhausting crops. Hence it follows that in nature innumerable means exist for favoring or insuring the dispersal of seeds; or, to speak more correctly, only those plants in the long run succeed in surviving which happen to possess some such facility for constant rotation and occupation of fresh districts.

It is very interesting in this respect to compare the devices for the distribution of their seeds in some of the thistle's own nearest and best-known relations. The burdock, for example, is in flower and fruit almost a thistle, though it differs considerably from the thistles proper in its large, broad, heart-shaped foliage. But the burrs, or ripe flower-heads, instead of being surrounded, thistle-fashion, by a very defensive prickly involucre, have developed instead hooked points to their bracts, which catch at once at the wool of sheep, the legs of cattle, and the dresses or trousers of wayfaring humanity. In this way the entire head of seeds gets carried about from place to place, and rubbed off at last against a hedge or post (at least by its unwilling four-footed carriers), where it forms the nucleus of a fresh colony, and starts in life under excellent auspices, especially if dropped (as it is apt to be) in the immediate neighborhood of a well-manured farm-yard. Hence the burdock has no further need for the down which it inherits, like all its tribe, from some remote common ancestor; it has substituted a new and more practically effective system of transport *en bloc*, for the old general composite mode of dispersal in single seeds by a feathery floating apparatus. Accordingly, the pappus, or ring of down, though it still exists as a sort of dying rudiment on each fruitlet of the burrs, is reduced greatly in size and expansion, and consists of a mere fringe of short, stiff hairs, useful perhaps in preventing flies from laying the eggs of their destructive grubs upon the swelling seeds. In the common knap-weeds, again, which wait for a high wind to shake out their seeds from the head, this dwarfing of the down has proceeded much further, so that at first sight a careless observer would never notice its existence at all: but if you look close at the ripe fruit with a small pocket lens, you will observe that it is topped by a ring of very minute, scaly bristles, occasionally mixed with a few longer and hairier ones, which are all that now remain of the once broad and feathery down. Among the true thistles, on the other hand, which trust entirely to the gentle summer breezes for dispersal, and which float away often for miles together, innumerable gradations of featheriness exist, some species having the down composed of long, straight, undivided hairs; while in others of a more advanced type it consists of regular feathered blades, barbed on either side with the most delicate beauty. Almost all our commonest and most troublesome English thistles belong to this last-named very feathery type, whose seeds are, of course, enabled to float about on the wind far more readily and to greater distances than the simple-haired varieties.

The thistle pedigree is a long and curious one. The group forms, apparently, the central and most primitive existing tribe of the composite family, and it bears in its own features the visible marks of a vast previous evolutionary history. Starting apparently from blossoms with five distinct and separate yellow petals, like the buttercups, the ancestors of thistlehood gradually progressed, as it seems, by insect selection, to a condition something like that of the harebell or the Canterbury bell, in which the petals have coalesced at their bases into a single large and united tube. Clustering together next into closely serried heads, like those of the scabious, the rampions, and the common blue sheepsbit, they endeavored to make up for the individual minuteness of their dwarfed flowers by the number and mass collected in a group on the summit of each stem. In this way they gradually assumed the distinctive crowded composite form, each floret consisting of a tubular five-lobed corolla, a calyx reduced to hairs or down, and single tiny seed-like fruit. Of this stage in the development of the family, the simpler and less specialized members of the thistle group, such as the unarmed saw-worts and the Alpine saussurea, are now the best surviving representatives. From some such early central form, the evolving composites split up and diversified themselves into all their astonishing and almost incredible existing variety. Some of them, varying but little in minor details from the parent stock, acquired prickly leaves and grew into the thistle kind, or developed hooked and sticky involucres, and were known as burdocks. Others, producing at their edge a row of brilliantly colored and attractive florets, which serve the purpose of petals for the compound head, branched off into all the marvelous wealth of daisies, asters, sunflowers, marigolds, dahlias, golden-rods, ox-eyes, and cinerarias. In yet others the whole mass of the florets, central as well as external, has assumed this ray-like or strap-like form ; and to this group belong the dandelions, hawk-weeds, salsifies, lettuces, sow-thistles, chiccories, nipplevorts, and cat's-ears. By far the most successful of all flowering plants, the composites have taken possession in one form or another of the whole world ; and among the entire wealth of their extraordinary diversity there is no group more universally fortunate than the common thistle. What from the purely agricultural point of view we describe as a very persistent and almost ineradicable weed, from the higher biological point of view we should more properly regard as a dominant and admirably adapted species of plant. The one conception is merely narrow, practical, and human ; the other is positive, philosophical, and universal.—*Longmans' Magazine.*

INEBRIATE MANIACS.

By T. D. CROTHERS, M. D.

PSYCHOLOGISTS and students of mental science have long been aware of the presence of a new division of the army of the insane, a division which is steadily increasing, more mysterious and obscure than the ordinary insane, and constituting a new realm of the most fascinating physiological and psychological interest. It consists of the alcoholic, opium, chloral, ether, and chloroform inebriates. They appear in law courts, as both principals and associates in all degrees of crime, and are called drunkards, tramps, and dangerous classes. In conduct, character, and motive, they constantly display many prominent symptoms of insanity, such as manias, delusions, deliriums, and imbecilities. Yet public opinion refuses to recognize these symptoms, because they are associated with intervals of apparent sanity in act and conduct. Clergymen and moralists teach that these cases are simply moral disorders, growing out of "a heart deceitful and desperately wicked," and only remedied by moral and legal measures. Scientists, who study the history and progress of these cases, find that they are diseases, following a regular line of march, from definite causes, on through certain stages of growth, development, and decline, the same as in other maladies.

Many theories are urged to explain the presence of this army of inebriates; one of which asserts that inebriety is evidence of the moral failure of the age, of the increasing wickedness of the times, of the triumphs of the growth of evil over the good, etc. Another theory assumes that the great increase in the manufacture of all forms of alcohol and other drugs, and the facility with which they are procured, will fully explain the presence of this class. A third theory considers them the defective, worn-out victims of this crushing, grinding civilization; the outgrowths of bad inheritance, bad living, and the unfit generally, who are slowly or rapidly being thrown out of the struggle. A fourth view regards them as simply coming into prominence, through the great advances in the physiology and pathology of the brain and nervous system, in which the physical character of these cases is recognized.

Inebriate maniacs have been called "border-land" lunatics, meaning persons who move up and down on the border-line between sanity and insanity, and, when studied closely, divide naturally into many classes. One of these classes, which in most cases represents extreme chronic stages, appears prominently in the daily press, in reports of criminal assaults and murders. When the genesis of the crime and the so-called criminal are studied, unmistakable symptoms of mental unsoundness appear. In most cases the victim is a neurotic by inheritance and growth. In other words, he was born with a defective brain and organism, and both growth and culture have been imperfect. Many and complex influences, among which alcohol or other narcotics may be prominent, have prepared the soil, furnished the seed, and stimulated the growth of a positive disease of the brain. The higher brain-centers have slowly succumbed to a paralysis, as mysterious as it is certain in its march. The victim's capacity to comprehend his condition, and adjust himself to the surroundings, becomes less and less, and he is more and more a waif drifting with every possible influence. In appearance, head, face, and body are angular and imperfectly developed, the nutrition is defective, the eye, the voice, and every act and movement indicate degeneration and disease. Any general history of the crime reveals delirium, hallucinations, delusions, and maniacal impulses. Thus, in one day, the papers recorded the following among other cases of this class: An inebriate, of previously quiet disposition, killed his wife, supposing she had put poison in his food. Another man in a similar state shot a stranger who differed with him on the age of Queen Victoria. Another man killed his father, who remonstrated with him for overdriving a horse. Still another assaulted fatally his brother, who would not give him money. Two men, both intoxicated, mortally wounded each other in a quarrel who should pay for the spirits drunk. Another man killed both wife and child, supposing the former was going to desert him. Thus, day after day, the records of these inebriate lunatics appear, and each case is as positively the act of a maniac as if committed by an inmate of an asylum, whose insanity was long ago adjudged. In each case, a long premonitory stage has preceded this last act; the individual history of almost every inebriate furnishes abundant evidence of this. In the courtroom this insanity of the prisoner is ignored, and the legal fiction, that drunkenness is no excuse for crime, prevails. The prisoner is assumed to be always a free agent, and the use of alcohol a willful act, the consequences of which he should be held accountable for. As a result, the victim is destroyed, and the object of the law, to reform the offender and deter others from the commission of crime, lamentably fails.

The second class of these inebriate maniacs are less prominent in the press, but more often seen in the lower and police courts. They are arrested for drunkenness, minor assaults, and all grades of breaches of the peace. They use alcohol, opium, or any other drug for its effect, and their character and conduct are a continuous history of insane and imbecile acts. In appearance they are suffering from disease, and the hereditary history is prominent in ancestral degenerations and defects. They are repeaters for the same offense over and over again, and their crime is of a low, imbecile type against both person and property, characterized by profound mental and moral paralysis. In popular estimation they are simply armies of vicious, wicked persons, who are so from love of the bad and free choice of evil. This idea prevails in the court-room, and the judge, with a farcical stupidity, admonishes, rebukes, and sentences these poor victims, who are supposed to be made better by the moral and physical surroundings of the prison, and the sufferings which the vengeance of the law inflicts. The case may have appeared many times before for the same offense, and the act committed may have been particularly insane and motiveless, and yet the judge deals out justice on the legal theory that the prisoner is of sound mind, and fully conscious and responsible. The result is clearly seen in the records of police courts, showing that the number of persons who are repeatedly arrested for drunkenness is increasing. Another result more startling, but equally true, appears. Every law court where inebriate maniacs are tried and punished, on the theory that drunkenness is no excuse for crime, and that the victim should be treated as of sound mind, with free will to do differently, is a court of death, more fatal than all the saloons and beer-shops in the world. Such courts destroy all possibility of restoration, and precipitate the victim to lower grades of degeneration. It has been estimated that ninety-nine out of every one hundred men who are arrested for drunkenness for the first time, and sentenced to jail, will be returned for the same offense within two years, and appear again with increasing frequency as long as they live. The report of the hospital at Deer Island, near Boston, where drunkards are sent on short sentences, for 1883, showed that one man had been sentenced to this place for the same offense, drunkenness, seventy-five times. Before the temperance committee of the English Parliament, in 1882, many cases were cited of men who had been sent to jails and work-houses from twenty to two hundred times for drunkenness. Practically, every sentence for drunkenness for ten, thirty, or sixty days, costs the tax-payers from fifty to one hundred and fifty dollars; and more completely unfits the victim for and removes him from the possibility of living a temperate, healthy life. Enthusiastic temperance men have drawn the most startling conclusions from these lower court records of arrests for drunkenness. Here each arrest stands for a new man and case. The nine thousand cases recorded as having been sent to Deer Island in 1883 in reality only represent a little over two thousand different men and women, and yet the number of arrests is taken as evidence of the increase of drunkenness.

A third class of inebriate maniacs are less common, and yet they often come into great notoriety from some unusual act or crime. They are known as moderate or occasional excessive users of alcohol; or opium and chloral takers. In most cases they are from the middle and better classes of society, and are beyond all suspicion of insanity, and their uses of these drugs are considered mere moral lapses. Such persons will suddenly exhibit great changes of character and conduct, and do the most insane acts, then resume a degree of sanity that corresponds with their previous character. Thus, a prominent clergyman of wealth and high standing in the community, who was a wine-drinker, suddenly began a series of Wall Street speculations of the most uncertain, fraudulent nature. He implicated himself and a large number of friends, and finally was disgraced. A judge, occupying a most enviable position of character and reputation, who had used spirits and opium for years at night for various reasons, suddenly gave up his place and became a low office-seeker—was elected to the Legislature, and became prominent as an unscrupulous politician. A New England clergyman, after thirty years of most earnest, devoted work, renounced the church and became an infidel of the most aggressive type. Later it was found that he had used chloroform and spirits in secret for years. A man of forty years, of tested honesty and trustworthiness, pròved to be a defaulter. It was ascertained that he used choral and opium in secret.

Hardly a year passes that bank defaulters, forgers, and swindlers do not appear among men whose previous character has given no intimation of such a career. When their secret history is ascertained, the use of alcohol, opium, and other drugs is found to be common.

Another class of previously reputable, sane men suddenly commit crimes against good morals. The unusual boldness of their acts points to insanity, and it is then found that they are secret or open drinkers, using alcohol or compounds of opium. Such men come into politics with a most insane ambition for office and childish delirium to appear in public as great men. They often become enthusiastic church and temperance men, acting along very unusual lines of conduct, and doing unusual things. Signs of mental failure are clearly traced in the childish credulity, or extraordinary skepticism, or extreme secretiveness, which are all foreign to the history of their past. Then, at last, such men leave strange wills, with strange bequests. They are contested ; the expert is called in ; and, while he is certain of insanity and irresponsibility of the testator from the history, he can not make it appear clearly to the court. These cases are more or less familiar to every one, yet the history of drinking or using narcotics is concealed. In an instance of recent date, the will of a very rich man contained a large bequest to the Freedman's Bureau. This was a very strange and unusual act ; but the heirs, rather than expose the secret drinking of the testator, let the will stand. To history this was a very generous deed, but in reality it was the mere freak of a maniac.

These persons appear to all general observation sane and fully conscious of the nature and character of their acts ; yet they are in a state of intellectual delirium and instability, which comes out prominently in the strange, unusual conduct. The co-ordinating brain-centers are so damaged as to prevent healthy, consistent, uniform brain-action. A certain range of thought and action may seem sane, but an ever-increasing undercurrent of disease carries them further from normal brain-health. These cases excite the wonderment of the hour, and to moralists are phases of human depravity ; but to the psychologist are explosions of masked diseases almost unknown and undiscovered.

It will be apparent to all that the most unfortunate treatment with miscarriage of justice is meted out to these cases. Thus, the inebriate maniac in delirium who commits murder and assault is not a criminal to be cured by punishment. His brain has broken down and needs the most careful restorative treatment. He is physically sick, and can never recover except by the use of well-directed remedies and along the line of exact laws and forces.

In the second class, the profound failure of the present methods of management should direct attention to the real means of cure. Science shows, beyond all doubt, that a system of work-house hospitals, where all these cases can come under exact physical care and restraint, and be organized into self-supporting quarantine stations, will not only protect the community and tax-payer, but put the victim in the best condition for permanent recovery. Here he can be made a producer, and taken from the ranks of consumers and parasites of society. If he is an incurable, he can be made self-supporting, and society and the world can be protected from his influence.

In the third class, when public opinion recognizes that the occasional or continuous use of alcohol or other narcotics is dangerous and likely to produce grave mental disturbance, these alterations of character and conduct will be no mystery. Such men will be recognized as diseased, and come under medical care and recover. Medical and scientific men must teach the world the nature and character of alcohol, and the diseases which are likely to come from its use. This moralists, clergymen, and reformed inebriates, can never do. To-day these inebriate maniacs appeal for recognition and sympathy from many homes and firesides. They call for help. They ask for bread. We are deaf to their entreaties—we give them stones. In language that can not be mistaken, they tell us of unstable brain-force, of tottering reason, of marked, insidious disease. We call it vice, and treat them as of sound mind and body. They ask for help for the brain, starved, disorganized, and growing feebler. We give them the pledge and prayer, and taunt them as vile, and willful, and wretched sinners. What wonder that the glimmerings of reason and the lights of a higher manhood should disappear in the darkness of total insanity under such treatment? In the delirium of criminal assault, or the imbecilities of the low drunkard, or the strange acts and changes of character in the so-called moderate drinker, they mutely appeal for aid, and we brutally fine, imprison, and persecute them. These are the spirit and theory which seek support through temperance efforts, through the church, and political parties, to remove an evil of which they have no comprehension. When all this thunder and roar of temperance reformation shall pass away, the still small voice of Science will be heard, and the true condition of the inebriate and the nature of his malady will be recognized.

SKETCH OF PROFESSOR EDWARD S. HOLDEN.

By WILLIAM C. WINLOCK.

PROFESSOR EDWARD SINGLETON HOLDEN, the President of the University of California, and Director of the Lick Observatory, was born in St. Louis, Missouri, on the 5th of November, 1846. He is a direct descendant of Justinian Holden, who came to this country from Kent, England, in 1636, and settled in Massachusetts on a tract of land which now forms a part of the city of Cambridge, but was then called, I believe, Watertown. Dr. William Holden, grandson of Justinian Holden, and Professor Holden's great-grandfather, afterward moved from Cambridge to Dorchester, Massachusetts, where the family resided till about 1830. The first eight years of Professor Holden's life were spent in St Louis, but about 1854 he was taken to Cambridge and placed at the private schools taught by Miss Ware and Miss Harris. It was during the six years spent here that he received his first idea of astronomy—from his cousin, Professor George P. Bond, then Director of Harvard College Observatory—and a certain occasion upon which he first saw the bright star α Lyræ through the fifteen-inch telescope made a lasting impression upon his mind.

In 1860 Holden returned to St. Louis and entered the preparatory academy of Washington University, from which, after two years' study, he passed into the Scientific School of the university. The young student soon attracted the attention of Professor Chauvenet, the accomplished mathematician and astronomer, then Chancellor of the University. Professor Chauvenet spent the winter of 1864–'65 in Minnesota for the benefit of his health, and during this time Mr. Holden formed a part of his household, and prosecuted his studies directly under Professor Chauvenet's eye.

In 1866 we find him assisting Dr. Gould in collecting the statistics of the United States volunteer soldiers from the State of Missouri, for the "Investigations in the Military and Anthropological

Statistics of American Soldiers," published by the United States Sanitary Commission, and in the same year he graduated with distinction from the Scientific School, receiving the degree of B. S. While at the university he also went over an important part of the classical course.

With a view of continuing his mathematical studies, he secured an appointment to the Military Academy at West Point through the Hon. J. W. McClurg, Representative of the Fifth Missouri District in Congress, and was admitted as a cadet to the Academy on the 1st of September, 1866. On the 15th of June, 1870, he was graduated, third in a class of fifty-nine members, and was appointed Second-Lieutenant of the Fourth United States Artillery. He was assigned to Company G of that regiment, and served with his command at Fort Johnston, North Carolina, until August, 1871, when he was ordered to duty at the Military Academy, West Point, as Assistant Professor of Natural and Experimental Philosophy. June 10, 1872, he was transferred to the Engineer Corps of the army, remaining at West Point, however, as instructor in practical military engineering.

During these few years at the Military Academy he published, in the "American Journal of Science," his first astronomical work—a short paper on the "Spectrum of the Aurora" and another on the "Spectrum of Lightning."

In March, 1873, Lieutenant Holden resigned his commission in the army, and was appointed Professor of Mathematics in the United States Navy, a position which his teacher Chauvenet had held before him. He was ordered to the Washington Naval Observatory, then under the direction of Rear-Admiral B. F. Sands, and his first duties in his new profession were as assistant to Professor Harkness in the work of the transit circle. Immediately, however, upon the completion and mounting of the twenty-six-inch equatorial—at that time the largest refractor in the world—he was transferred, November 15, 1873, to duty as assistant to Professor Newcomb, who had been placed in charge of that instrument.

The results of Professor Holden's work during six years of observation with this instrument, first as assistant to Professor Newcomb, and afterward as assistant to Professor Hall, have been printed in the volumes of the Observatory publications and in various astronomical journals. Turning over the files of the "Astronomische Nachrichten" for these years, we find numerous observations of comets and of double stars, of the satellites of Uranus and Neptune, and of the companion of Sirius; but, besides all this rather prosaic routine work, Professor Holden devoted himself zealously to the more fascinating study of the physical features of the planets and nebulæ. His most elaborate investigation in this field is given in the

"Monograph of the Central Parts of the Nebula of Orion," an exhaustive *résumé* and discussion of all the observations hitherto made on the central parts of this interesting nebula. Professor Holden's own observations were made with the twenty-six-inch equatorial from 1874 to 1880, their main object being to provide sufficient data to determine with certainty in the future whether or not changes have occurred in the nebula. His conclusion, from a thorough discussion of the large mass of material already available in the observations of two hundred and twenty-four years, is briefly, that "the figure of the nebula of Orion has remained the same from 1758 to now (if we except a change in the shape of its apex (E) about 1770, which appears quite possible); but that in the brightness of its parts undoubted variations have taken place, and that such changes are even now going on."

In June, 1876, Professor Holden went to London, under instructions from the Secretary of the Navy, to examine and report on the South Kensington Loan Collection of Scientific Instruments, giving especial attention to improvements in astronomical and geodetic instruments. An interesting portion of the report (which may be found in full in the report of the Secretary of the Navy for 1876) is that relating to the system of time-signals, etc., in use in foreign countries. Considerable attention was also given to methods of testing chronometers. The time-ball on the Western Union Telegraph Building in New York was erected according to his plans in 1879.

Professor Holden observed the transit of Mercury of May 6, 1878, in co-operation with his friend Dr. Henry Draper, at the latter's private observatory at Hastings; and later in the same year he was put in charge of a party to observe the total solar eclipse of July 29th. The station selected was Central City, Colorado, an altitude of some 8,400 feet above sea-level. Professor Holden's special work was the examination of the sky about the sun for the detection of the hypothetical planet Vulcan—a search which, as we know, was fruitless. In 1879 he took charge of the library of the Naval Observatory, and in 1880 he was transferred from duty with Professor Hall to duty on the transit circle with Professor Eastman, taking part in the observations with this instrument in addition to his work as librarian. His connection with the library is marked by several valuable contributions to astronomical bibliography, notably "A Subject-Index to the Publications of the United States Naval Observatory, 1845–1875," an "Index Catalogue of Books and Memoirs relating to Nebulæ and Clusters," and a work undertaken in connection with Dr. Hastings, "A Synopsis of the Scientific Writings of Sir William Herschel."

Upon the death of the distinguished astronomer, Professor James C. Watson, Professor Holden accepted the position thus made vacant, of Professor of Astronomy in the University of Wisconsin and Director of the Washburn Observatory; and obtaining, at the request of Governor Washburn, a leave of absence from the Naval Observatory, February 2, 1881, he immediately proceeded to Madison to take charge of the observatory, which was then in an entirely unfinished state: his official connection with the navy was not severed till June 1, 1882. Professor Holden's five years of administration of the Washburn Observatory have established it in the foremost rank of American observatories. Four volumes of publications have been issued, the last one containing the most important piece of work of the Repsold meridian circle, the determination of the positions of the 303 fundamental stars for the southern zones of the "Astronomische Gesellschaft"; to form, however, an adequate idea of the varied labors of the director and his assistants, reference must be made to the volumes themselves. In 1883 Professor Holden's work at Madison was interrupted for several months, to conduct the Government expedition to Caroline Island in the South Pacific mid-ocean, for the purpose of observing the total eclipse of the sun on May 6th. Professor Holden's chosen task was again, as in 1878, the search for intra-Mercurial planets, and with the exceptionally long duration of totality—nearly six minutes—this search was made under most favorable circumstances, and again resulted negatively. The account of this expedition, contained in an interesting memoir of the National Academy of Sciences, will be found to be "much more than a technical report on the dry scientific details of the work of eclipse-observers": it includes an entertaining narrative of the ocean-voyage of twenty-nine days from Callao, and a complete history and description of the lonely little island, with photographic views of the characteristic vegetation and reef-beeches.

Professor Holden's resignation of the chair of Astronomy at Madison took effect on the 1st of January, 1886, upon his acceptance of his present position, the presidency of the University of California, and directorship of the Lick Observatory. Since 1874 he has been one of the chief consulting astronomers to the Lick trustees, who, under the provisions of the will, have charge of building and equipping the observatory. In 1881 he visited Mount Hamilton and successfully observed the transit of Mercury; in 1883 he visited it again, and in 1884 he went out again to superintend the erection of the fine Repsold meridian circle. The Lick Observatory, as it approaches completion, has received so much attention in scientific and popular journals, that a description of it seems hardly necessary here. The giant thirty-six-inch objective—through which "the observer might expect to see the moon much the same as he would without the telescope if it were only a hundred miles away," and might make out objects on the moon's surface "although they were no larger than some of the larger edifices on the earth"—is now in a fair way to be finished by the Clarks during the autumn of the present year; the steel dome will probably be finished about the same time, and the telescope tube, which is being made by Messrs. Warner and Swasey, of Cleveland, will be ready in June, 1887. The trustees only await the mounting of this instrument, to turn over the observatory formally to the University of California. Meanwhile the observatory, as it now stands, with a twelve-inch Clark equatorial, a six-inch equatorial, a six-inch Repsold meridian circle, photographic instruments, clocks, chronometers, and all accessory apparatus, and an extensive library, is far better equipped than most observatories, and Professor Holden, with characteristic energy, has already begun an extensive series of observations with the meridian instrument, and has established a time-service for the benefit of the railroads connecting with San José.

This brief sketch merely attempts to outline Professor Holden's career as an astronomer. His administrative experience and ability were proved at Madison, and as a teacher he seems to have shown the rare faculty of arousing the enthusiasm of his pupils. His general interest in many matters outside of his profession may be seen by a glance at the partial list of his writings which is appended. This bibliography I have made tolerably full, though by no means exhaustive; I have found nearly one hundred papers, etc., contributed to scientific journals and transactions between the years 1873 and 1886; and the titles that I have given will form in themselves an effective "sketch" of his work. His life of Sir William Herschel should be referred to especially: it has been published in London as well as in New York, and has also been translated and published in Germany. A text-book of astronomy, published in co-operation with Professor Newcomb, has likewise been favorably received, and has passed through several editions.

In 1879 Professor Holden received the degree of A. M. from his alma mater, and the University of Wisconsin has just conferred the degree of LL. D. on its former professor. He is a member of the California and Wisconsin Academies of Science, Fellow of the American Association for the Advancement of Science, member of the Philosophical Society of Washington, and of the German Astronomische Gesellschaft, Corresponding Member of the Academy of Science of St. Louis, Associate Fellow of the American Academy of Arts and Sciences, Foreign Associate of the Royal Astronomical Society, and member of the National Academy of Sciences. While at Madison he was connected with Professor Raphael Pumpelly's Northern Transcontinental Survey, as head of the Division of Climate and Rivers, and in 1885 he served as a member of the Board of Visitors to the United States Military Academy at West Point.

Professional and other Papers by E. S. Holden (in general chronological order).

No.	Title.	Place and date of publication.
1	On a New Arrangement of Shutters for a Dome for an Equatorial Telescope.	Am. Jour. Sc., 3 s., 6: 375-377 (Nov., 1873).
2	On the Adopted Value of the Sun's Apparent Diameter.	Bull. Phil. Soc. Wash. 1 (App. 1): 3-9 (Jan., 1874).
3	On Sir William Herschel's Observations of the Satellites of Uranus.	Bull. Phil. Soc. Wash. 1 (App. 4): 30-36 (June, 1874).
4	Telescopic Research on the Nebula of Orion. (Illustrated.)	Pop. Sc. Month., 5: 257-268 (July, 1874).
5	On the Inner Satellites of Uranus.	Proc. Am. Ass., 23: 49-56 (Aug., 1874; Month. Not. Roy. Astron. Soc., 35: 16-22 (Nov., 1874).
6	On the Possible Periodic Changes of the Sun's Apparent Diameter [by Newcomb and Holden].	Am. Jour. Sc., 3 s., 8: 268-277 (Oct., 1874).
7	On the Number of Words used in Speaking and Writing.	Bull. Phil. Soc. Wash. 2 (App. 6): 16-21 (Jan., 1875).
8	Drawing of the Ring Nebula in Lyra.	Month. Not. Roy. Astron. Soc., 36: 61-69 (Dec., 1875).
9	[Progress of Astronomy in 1876.] [*Note.*—This annual review of astronomy is continued in Professor Baird's Annual Record for 1877 and 1878, and subsequently in the Smithsonian Reports.]	Ann. Rec. Sc. and Indust., 1876, pp. xvii-xxvi.
10	Report upon the Astronomical Instruments of the Loan Collection of Scientific Instruments at the South Kensington Museum, 1876.	Rept. Sec. Navy, 1876, pp. 289-314.
11	The Horseshoe Nebula in Sagittarius. (Illustrated.)	Pop. Sc. Month., 8: 269-281 (Jan., 1876).
12	On Supposed Changes in the Nebula M. 17.	Am. Jour. Sc., 3 s., 11: 341-361 (May, 1876).
13	Comparison of the Washington Observations of the Satellite of Neptune with Newcomb's Tables.	Astron. Nachr., 88: 183-188 (July, 1876).
14	On Reference Catalogues of Astronomical Papers and Memoirs.	Bull. Phil. Soc. Wash., 2: 95-101 (Dec., 1876).
15	Index-Catalogue of Books and Memoirs relating to Nebulæ and Clusters, etc.	Washington, 1877. 9+109+[2] p. 8°. (Smithsonian Misc. Coll., vol. 14).
16	Observations of the Satellites of Neptune and Uranus, and of the Companion of Sirius.	Astron. Nachr., 90: 161 (July, 1877).
17	[Observations of Comets *a*, *b*, *c*, 1877.]	Astron. Nachr., 90: 167, 170, 331 (1877).
18	On the Proper Motion of the Trifid Nebula. (Illustrated.)	Am. Jour. Sc., 3 s., 14: 433-458 (Dec., 1877).
19	Index-Catalogue of Books and Memoirs on the Transits of Mercury.	Cambridge, 1878. 6 pp., 8°. (Lib. Harv. Univ. Bibliog. Contrib., No. 1).
20	Note on the Reticulated Forms of the Sun's Surface.	Am. Jour. Sc., 3 s., 16: 346 (Nov., 1878).
21	A Subject-Index for the Publications of Observatories.	Library Jour., 3: 365 (Dec., 1878).
22	Catalogue of the Library of the United States Naval Observatory. Part I, Astronomical Bibliography.	Washington, 1879. 10 pp. 4°.
23	A Subject-Index to the Publications of the United States Naval Observatory, 1845-1875.	Washington, 1879. 74 pp. 4°. (Washington Observations, 1876, App. I.)
24	Reports of Observatories, 1879.	Smithsonian Rep., 1879, p. 455-512
25	The Cipher Dispatches.	Internat. Rev., 6: 405-424 (April, 1879).
26	Astronomy for Students and General Readers [by Newcomb and Holden]. (Illustrated.)	2d ed. New York, 1880. 11 + 512 pp. 8°.
27	Note on a Relation between the Colors and Magnitudes of the Components of Binary Stars.	Am. Jour. Sc., 3 s., 19: 467-472 (June, 1880).
28	On the Treatment of Pamphlets in Special Libraries. (Illustrated.)	Library Jour., 5: 166 (June, 1880).
29	On some of the Consequences of the Hypothesis recently proposed, that the Intrinsic Brilliancy of the Fixed Stars is the same for each Star.	Proc. Am. Ass., 29: 137-151 (Aug., 1880).
30	Sir William Herschel: his Life and Works.	New York, 1881. 6 + 238 pp. (Portrait.) 12°.

Professional and other Papers by E. S. Holden (in general chronological order)—(continued).

No.	Title.	Place and date of publication.
31	A Synopsis of the Scientific Writings of Sir William Herschel [by Holden and Hastings].	Washington, 1881. 114 pp. 8°. (From Smithsonian Rep., 1880.)
32	Reports of Observatories, 1880.	Washington, 1881. 126 pp. 8°. (From Smithsonian Rep., 1880.)
33	An Account of Recent Progress in Astronomy (for the Years 1879 and 1880). [*Note.*—Similar reviews will be found in the Smithsonian reports for 1881, 1882, 1883, and 1884.]	Washington, 1881. 37 pp. 8°. (From Smithsonian Rep., 1880.)
34	Studies in Central American Picture-Writing. (Illustrated.)	1st Ann. Rept. Bureau Ethnol. Smithson. Inst., pp. 207–245 (1881).
35	Investigation of the Objective and Micrometers of the 26-inch Equatorial constructed by Alvan Clark and Sons.	Washington, 1881. 44 pp. 4°. (Washington Observations, 1877, App. I.)
36	The multiple star Σ 748.	Washington, 1881. 22 pp. 4°. (Washington Observations, 1877, App. II.)
37	List of Red Stars observed at the Washburn Observatory.	Copernicus, 1; 176 (1881).
38	Observations on the Light of Telescopes used as Night-Glasses.	Am. Jour. Sc., 3 s., 22: 129–131 (Aug., 1881).
39	Observations of Comet *b* 1881 [1881, III], made at the Washburn Observatory. (Illustrated).	Am. Jour. Sc., 3 s., 22: 260–263 (Oct., 1881).
40	Publications of the Washburn Observatory of the University of Wisconsin. Vols. i, ii, iii, iv.	Madison, 1882–'86. 4 vols. 8°.
41	Monograph of the Central Parts of the Nebula of Orion. (Illustrated.)	Washington, 1882. 230 pp. 4°. (Washington Observations, 1878, App. I.)
42	Observations of the Transit of Mercury, 1881, Nov. 7, at Mount Hamilton, California.	Am. Jour. Sc., 3 s., 23: 48 (Jan., 1882).
43	On the Inclination of the Ring of Saturn to its Orbit, deduced from Washington Observations.	Month. Not. Roy. Astron. Soc., 42; 304–307 (April, 1882).
44	Measures of the Rings of Saturn in the Years 1879, 1880, 1881, and 1882.	Am. Jour. Sc., 3 s., 23: 387–394 (May, 1882).
45	Figure of the Nucleus of the Bright Comet of 1882 [1882, II]. (Illustrated.)	Am. Jour. Sc., 3 s., 24: 435 (Dec., 1882).
46	Report of the Eclipse Expedition to Caroline Island, May, 1883.	Mem. Nat. Acad. Sc., 2: 1–146 (1883).
47	Observations of the Transit of Venus, made at the Washburn Observatory.	Am. Jour. Sc., 3 s., 25: 71–74 (Jan., 1883).
48	List of Twenty-three New Double Stars discovered at Caroline Island by E. S. Holden and C. S. Hastings.	Science, 2: 66 (July 20, 1883).
49	Preliminary List of Errata in Yarnall's Catalogue.	Astron. Nachr., 107: 261–268 (Oct., 1883).
50	A System of Local Warnings against Tornadoes.	Science, 2: 521 (Oct. 19, 1883).
51	Proper Motion of Lacaille 8262.	Astron. Nachr., 107: 273 (Oct., 1883).
52	The Narrow Belt on Saturn. (Illustrated.)	Observatory, 7: 74 (Mar., 1884).
53	Statistics of Stellar Distribution derived from Star-Gauges and from the Celestial Charts of Peters, Watson, Chacornac, and Palisa.	Observatory, 7: 249–256 (Sept., 1884).
54	The Lick Observatory.	Sid. Mess., 3: 301–303 (Dec., 1884). *See also* Overland Mon., n. s., 6: 651–655 (Dec., 1885).
55	Sketch of Professor S. P. Langley.	Pop. Sc. Month., 27: 401–409 (July, 1885).

EDITOR'S TABLE.

AN UNHAPPY "SURVIVAL."

CONSIDERING that we are drawing near to the end of the nineteenth century, and that the thought of our day is supposed to be more or less dominated by the scientific spirit, it is extraordinary to find certain words and phrases in common use that imply a survival of modes of thought proper only to periods of barbarism. As an example we would cite the word "luck," and all the familiar phrases in which that word is employed. By common consent, apparently, "luck" is a thing not to be defined; but it is none the less spoken of—and that not only by the ignorant and uneducated—as something exercising a real and potent influence on the affairs of men. It is qualified as good or bad: the man who has good luck enjoys the protection, as it were, of a guardian angel; the man who has bad luck is haunted and pursued by a malignant spirit. It is not men only who can be "lucky" or "unlucky"; ships, houses, railway lines, special days, special numbers, special gems, etc., may likewise fall into either category. It is even fashionable to talk about "mascots"—a mascot being an object, animate or inanimate, that contributes to the good fortune of its possessor. Thus we read a few days ago in one of our daily papers of a dog that was, as the traveling public believed, the "mascot" of a steamboat. The rage for horseshoes, as "lucky" things to nail up on one's premises, is perhaps as great as ever it was. Fashionable society, particularly, seems disposed to fondle the superstitions that science is laboring to banish. The light has come into the world, but there are those who neither comprehend it nor wish to comprehend it. Even on the part of men of scientific mind we find occasionally an unguarded use of language suggesting a participation in beliefs which, if seriously presented, they would strenuously condemn. Thus that excellent writer, Mr. S. Laing, author of one of the most interesting and useful books of the present day, "Modern Science and Modern Thought," says, in the concluding chapter of that work, that, if a laboring-man has once saved ten pounds, he may, "*if he has any luck*, readily make the ten a hundred or even a thousand pounds." Now, we think this an unfortunate expression: the idea it suggests is one which the writer would be the first to repudiate; and yet it might easily be quoted as evidence that even a most enlightened scientific writer recognizes "luck" as an element of success.

There is little use, probably, in arguing with people whose belief in luck is sincere and deep-seated. Such must be left to the education of experience and the influences of the time; and, likely enough, even with these aids, they will not unlearn their errors. But there is another class who, when they use the terms "luck" and "lucky," do so in a careless, indolent manner, or at most with only a half-belief that the words have any real significance. To these it may be well to represent that to talk of "luck" is simply to shuffle out of the responsibility of assigning things to their proper causes; and that, while this careless way of talking may do no special harm to the intelligent man who knows better than to be imposed upon by his own phrases, it does harm to people of less intelligence by confirming them in their delusions. It might perhaps be affirmed, indeed, that no man, however intelligent, can altogether escape harm if he permits himself the habitual use of terms implying degraded forms of belief. There is such a thing as intellectual pitch, which people who want to have their thoughts clean should be careful not to handle.

The career of President Cleveland is often spoken of as a great example of "luck," and this in quarters where one would expect more rational discourse. We imagine that President Cleveland knows pretty well how to account for his so-called luck. He knows that it has been a matter of hard work, of close attention to business, and of presumed identification with a rising popular sentiment in favor of improved political methods. "But," some inveterate believer in luck may urge, "other men have fulfilled all these requirements, and yet have never become Presidents or even Governors. Why should Cleveland, in particular, have been so successful?" We have here a fine example of one of those questions which, as Mr. Spencer says in his chapter on the "Data of Philosophy," imply very much more than the questioner is aware of. It implies that there are some reasons why the particular man who succeeded should *not* have succeeded; for, if there were no reasons to the contrary, what is the sense of asking why a man succeeded who had, admittedly, the qualifications for success? No conceivable action of social and political forces could raise every man, or even every qualified man, in a community to presidential rank; and yet some one man must, at every moment, hold that rank. What need, therefore, to suppose that a mysterious influence called "luck" has anything to do with determining the choice of the community? We see what we may call impersonal forces at work which, from their very nature and the conditions under which they operate, *must* result in the choice of one and the passing over of many others; and yet, when this inevitable result has been arrived at, some people are not satisfied until they have dragged in "luck" to account for it! There are thousands of events that can not be foreseen, the elements on which they depend being too complex for calculation; but none the less are they, and must they be, determined by natural causes. When we cant over a stick of timber, we can predict with certainty how it will fall; partly because the forces brought to bear upon it are of a simple character, and partly because their ratio to the work to be done—to the weight to be moved—is such that a little more or less will not affect the main result. But when we rattle dice in a box, the conditions are reversed: the forces now are many and complex, and are vast in relation to the work to be done. What will be their outcome in the position of the dice on the table, it is altogether beyond human skill to calculate. Were the stick of timber to be hurled from a volcano, carried along by a mighty torrent, or blown up by dynamite, its movements too would become incalculable; but the laws of Nature would not, on that account, lose their hold of it for one moment. Neither do the laws of Nature lose their hold of the dice. There is really no chance in either case; simply an inability on our part to foresee, and therefore to adjust ourselves in advance to, a result which the laws of Nature are working out. If we look closely into the matter, we shall see that all chance occurrences, or what we call such, are simply occurrences lying outside of the range of our calculations, and to which therefore we can only adjust ourselves *after* the event, whereas, in the case of things we foresee, we make, or may make, our adjustments beforehand. As knowledge increases, and methods of observation and reasoning improve, many things pass from the region of the incalculable to that of the calculable, and, to an infinitely enlarged intelligence, all that appears to us now as most completely fortuitous would appear as the direct and inevitable result of certain interactions of force.

The man who talks of luck, meaning anything by it, simply throws dust in his own eyes, and blinds himself to the natural and ascertainable causes on which many results of more or less importance to himself depend. He blames his luck, when he should blame some specific short-coming in his own conduct. He attributes another man's success to luck when he should attribute it to prudence, ability, or character. There is a vast amount of "luck" in being always ready to take advantage of opportunities. It is a happy thing to have one's lamp trimmed and burning; and a most unhappy thing to have to go off in quest of oil when the hour of the festivity arrives. Some would call the first a case of good luck, and the latter a case of bad luck; but we fail to see why such outlandish terms should be applied to preparedness on the one hand and unpreparedness on the other. As we have already said, we must make allowance in life for the unforeseen and uncontrollable; but the general law holds good that he who wisely calculates what admits of calculation, and wisely controls what admits of being controlled, will place his life and happiness on sound foundations. Such a man will have little reason to complain of luck and little disposition to praise it. We suggested, last month, a theme for teachers in our public schools; we suggest, this month, another—the folly of trusting to luck, and the almost equal folly, on the part of those who do not believe in luck, of talking as if they did.

THE RECENT EARTHQUAKE.

The earthquake of the night of the 31st of August, by which the city of Charleston, South Carolina, suffered severely, was generally felt throughout the States east of the Mississippi River, extending along the Atlantic coast from the Gulf of Mexico to Northern New England, and being perceptibly felt in several towns on the Mississippi. It was more strongly felt in the South than in the North, and the center of most violent manifestation was at Charleston, or near it. In other parts of the country the strength of the shock varied without any obvious rule, spots at a very short distance from one another feeling it in very different degrees. The time of the shock was fixed at about 9·54 Eastern standard time, while the gradual retardation in going west showed that the propagation of the movement was generally in that direction. At Charleston, the earthquake was extraordinarily severe. Many buildings were destroyed, the historic churches of St. Michael and St. Philip were ruined, between fifty and one hundred persons were killed, telegraphic communication was interrupted, and the streets were so filled with rubbish, or so dangerous in consequence of the imminence of tottering walls, that business was suspended for several days. Hardly a house in the city, it was said, escaped injury, and many were so shaken and cracked that a hard blow would bring them to the ground. The shock was equally severe at Summerville, where the whole business part of the town was wrecked, and several lives were lost. At Tybee Island, at the mouth of the Savannah River, the lenses in the lighthouse were broken, and the machinery of the lamps was disarranged, while the water was so agitated that the approach of a tidal wave was for a time apprehended. At Cleveland, Ohio, clocks whose pendulums swung east and west stopped at half-past nine, local time. The most coherent observations of the phenomenon were made at Washington in the Signal-Service Office, and by Mr. McGee, of the Geological Survey, and Professor Simon Newcomb. At the Signal-Service Office four shocks were noticed, of which the first lasted forty seconds and was most severe. The first of the three or four shocks mentioned at Charleston was also the most severe and was the one that did the principal damage. The second shock lasted four seconds, and the third and fourth shocks were very light. Professor Newcomb observed three shocks, the first of which he fixed at 9·53·20. Mr. McGee, after the culmination of the first shock, timed the phenomena, improvising a seismoscope out of a tumbler of water placed on a stand, and a rude seismometer out of the high head-board of his bedstead. The following is the record of his observations:

"Time of culmination of first shock (seventy-fifth meridian) 9·54½; duration of first shock (estimated), eighty seconds; time of termination of same, 9·55; time of termination of the slight tremor, 10·00 (several slight tremors followed but were not timed); time of recommencement of continuous tremors, 10·08; time of culmination of the second shock, 10·09½; duration of second shock, about thirty seconds; time of termination of second series of tremors, 10·13. The direction of vibration, as indicated by the improvised seismoscope, was a little north of east, but there was an indeterminate vertical component in the undulation plainly perceptible in the motions of liquids and of articles of furniture. Roughly, the upward impulse in each vibration appeared to be one third or one half of the lateral impulse.

"The rate of vibration was measured on the high, swinging head-board of a bedstead during the second shock, and found to be one hundred and fifteen or one hundred and twenty per minute. During the second shock the head-board, eight and a half feet high, swung through an arc of from one half to three quarters of an inch. It was estimated that the amplitude of oscillation during the earlier shock was twice or thrice as great."

Mr. Richard Randolph, civil engineer, of Baltimore, gives the time of the first shock as 9·53½. The oscillations in his room were emphasized by the synchronous beating of some object in his bedroom, which upon examination he found to be the tapping of the door of a wardrobe, and that, he observes, could only be produced with an east-and-west oscillation. To reproduce the tappings with the intensity and period that marked them during the earth-movement required a movement of half an inch at six and a half feet from the floor, for a complete oscillation. At Rochester, New York, a magnetic storm was observed to be raging all the morning of September 1st. It was observed, at the Signal-Service Office in Washington, that the self-registering wind-vane showed a horizontal mark preceding and subsequent to the shaking, denoting a mild, steady breeze, but, for the thirty or forty seconds of most violent shaking, the marks indicated great and rapid agitations of the registering-pencil. Captain Vogel, of the steamer city of Palatka, observed at sea, twelve miles off Port Royal, "a terrible rumbling sensation," which lasted about a minute and a half. There had been a heavy sea from the southeast, but when the rumbling began the wave-motion ceased and the waters remained perfectly quiet until the rumbling stopped, when the wave-motion again became manifest. The depth of the water at Charleston has not been greatly affected; but, according to Captain Boutelle, it has been increased by from six inches to a foot. Fainter shocks have been reported from Charleston as occurring nearly every day since the principal catastrophe.

THE BRITISH AND FRENCH ASSOCIATIONS.

The meetings of the British and French Associations this year were successful from both scientific and material points of view. The city of Birmingham, where the British Association met, provided so well for the accommodation and entertainment of its guests, that Mr. Galton, in seconding the usual vote of thanks to the people, said that the meeting would stand prominent in regard to comfort as well as to its scientific qualities. In the latter feature it stood very high. The programme in every section was full to excess, so that, while usually all the sections have finished their work on the Tuesday, and some of them on the Monday, five sections had this year to meet on the Wednesday. In all, three hundred and eighty-eight papers and reports were brought forward, the larger numbers of which were, in mathematics eighty-four, and geology seventy-seven. A new feature, and one the introduction of which was crowned with unexpected success, was that of provision for the discussion in some of the sections of subjects of unusual and pressing importance. The discussions on this plan in the joint meetings of the Physical and Biological Sections on color-vision, and in the Geographical Section on geographical education, were particularly edifying. Another discussion which followed the reading of a paper by Mr. Seebohn, on the theory of physiological selection, recently announced by Dr. Romanes, in which Professors Michael Foster and Newton and Francis Darwin took part, showed that the prevailing sentiment of the section was still in favor of Mr. Darwin's view and against Dr. Romanes's proposed modification of it. Another instructive discussion was on the existence of a pre-glacial man. About the usual proportion of the papers read were of a technical or special character, and a few were perhaps hardly at home in such a body as this; but the very full reports of the meetings in the London "Times," occupying about twenty-five columns, show how much was said and done that was of such living interest and value as to appeal to the general public. The addresses of the sectional presidents, of the essential features of which we give abstracts in another place, were for the most part attractive and intelligible presentations of the particular fields of research in which their authors are engaged. Public interest in the meetings may be gauged by the fact of the sale of twenty-five hundred membership tickets. Appropriations of thirteen hundred pounds sterling were made in encouragement of research in numerous fields. The meeting of the French Association was held at Nancy, under the presidency of M. Friedel, the chemist, and was marked by a numerous attendance and the presentation of a good list of papers, indicating a healthy growth. The secretary reported that three hundred and forty-two contributions had been presented at the Grenoble meeting of last year—being within forty-six of the number offered at the British Association this year. The treasurer presented reports showing that the financial strength of the Association and its consequent power for usefulness were steadily increasing.

LITERARY NOTICES.

Aristocracy in England. By Adam Badeau. New York: Harper & Brothers. 1886. Pp. 306. Price, $1.25.

There was need of such a volume (especially in this country) as that which General Badeau has here prepared. The truth is, that our national independence and the birth of the Great Republic consisted in little else than a formal repudiation of the British aristocratical system—monarchy and nobility; so that it can hardly be expected that the American people would be very impartial judges of the merits of a system we have got rid of under such circumstances. Our general idea is, that the English aristocracy is a worn-out, worthless, useless, ridiculous, and tyrannical system that is destined to disappear in a very few years. But American contempt for English aristocracy hardly equals American ignorance of it.

General Badeau recognized that there was wanting a book that should give an intelligible account of the aristocratic side of English life by explaining the parts and general working of the scheme. He desired to make the American reader understand the facts in such a way as to avoid injurious prejudice and favor an intelligent judgment. His subject is by no means a trivial or frivolous one. Aristocracy is a phase of society in some of its forms universal; and the English aristocracy is the best-preserved and most perfect and powerful in the world.

The author of this volume is a thorough-going democrat in the sense that he is no believer in aristocracy, and condemns it of course unsparingly; but he is unbiased enough to give a trustworthy account of its mechanism and workings. For this he seems to have very well prepared himself. Besides wide reading and special study of its various elements, he has had a dozen years' direct observation and experience of it in the diplomatic service.

It is the care with which he has availed himself of these opportunities that gives, perhaps, the most attractive feature to his book; he is full of anecdotes, incidents, brief personal sketches, and vivid delineations of the working of the various social parts in the aristocratic life. General Badeau has not attempted a philosophical book. While his volume is full of instructive lessons, he runs into no deep disquisition, and has struck the happy medium that will make it entertaining to all readers. The subject is not only a fascinating one, but a most important one, and, if we may venture to say so, a good deal more important than would appear from General Badeau's treatment of it. The author confines himself, in accordance with his plan, to descriptive details of the social operations that English aristocracy involves, and this probably prevented him from dealing with some of the remoter influences of the aristocratic policy. But the problem of the influence of aristocratical organizations in England on the whole subject of education for several centuries, and at the present time, is one of the most pregnant that the student of modern mental development has to deal with. General Badeau's book is an excellent introduction to this subject, but the author does not enter upon it.

The Jugurthine War of C. Sallustius Crispus. Edited, etc., by Charles George Herbermann. New York: D. Appleton & Co. Pp. 272. Price, $1.12.

The editor has aimed, in preparing this volume, to assist the student, as far as possible, with all the resources of modern scholarship; and, in compiling the notes, he has endeavored to omit nothing in the way of historical illustration that can aid the learner to obtain a fuller and clearer insight into the meaning and spirit of the author. The text of Jordan, which is in the best repute in German and English schools, has been adopted, while archaisms and variations in spelling are avoided, as only likely to perplex students. Besides the notes, an introduction giving the life of Sallust, observations on his style and syntax, and historical information respecting the kingdom of Numidia and the Jugurthine war, has been added; and a convenient vocabulary saves the necessity of encumbering one's self with a separate dictionary.

A History of Education. By F. V. N. Painter. New York: D. Appleton & Co. Pp. 335. Price, $1.50.

This is the second volume of the "International Education Series," which D. Appleton & Co. have projected, to be prepared under the editorial supervision of W. T. Harris, to provide works of a useful and practical character for the libraries of teachers and school managers, and text-books in normal classes. The author is Professor of Modern Languages and Literature in Roanoke College, Virginia; and the preparation of this history was suggested by him while examining the German works on the subject in the library of the University of Bonn, in view of the poverty of our literature in educational history. In it he views the history of education from the point of the philosophy of history, or history of civilization, and traces it in its relations with the social, political, and religious conditions of each country. The system of education in each nation is regarded as conformed to its religion, art, social customs, and form of government, but most of all, generally, to its religion. Hence, a new phase of civilization, giving new ideals in these domains, demands a new system of education. The systems that have prevailed from the remotest past down to the present time have been modified by all the changing conditions of national life to which they have been conformed, and have been molded in sympathy with the ideas which were dominant in the races among which they have been applied. Following the subject in its chronological and logical relations, attention is first called to the Oriental countries, in which are included China, India, Persia, Palestine, and Egypt. In these lands, the individual counts for nothing; and education does not aim to develop a perfect man or woman, but to prepare its subjects for their place in the established order of things. Subjection to authority is the principle on which most stress is laid, while the source of the all-controlling authority may vary in the different countries. Quite different were the ideas in the classical nations, Greece and Rome, where the individual was brought into prominence: education was made the subject of careful thought and was controlled by higher principles; enlarged views of its nature were promulgated; and beautiful results were obtained as exhibited in the physical and intellectual life of the people. With the Christian dispensation came a new era in history, and education was profoundly affected and placed on a new and immovable foundation. The history of Christian education in Europe and America is naturally divided into two periods—the period before the Reformation and the period after the Reformation. The story of the latter period is largely occupied with the struggle between the "humanist" and the "naturalist" or modern tendencies, which has continued and is still going on in our own day. Finally, under the heading of "Education in the Nineteenth Century" are reviewed the systems of Pestalozzi and Froebel, and contemporary education in Germany, France, England, and the United States.

The Depression in Trade and the Wages of Labor. By Uriel H. Crocker. Boston: W. B. Clarke & Carruth. Pp. 31.

Mr. Crocker is the author of the pamphlet entitled "Excessive Saving a Cause of Commercial Distress," which was noticed in the "Monthly" several months ago. In the present pamphlet he continues the discussion of the subject, and endeavors to give his views a practical direction. Reviewing the various theories that have been advanced to account for the present supposed hard times—when the "suffering" working-men are rejoicing to put themselves in idleness—he plants himself upon that which ascribes the depression to over-production. "We have," he says, "increased production by bending all our energies in that direction, aided all the while by the immense increase in the effective power of the machinery of production and distribution, and by the fact that years of labor spent in the creation of that machinery have brought us to a time when we are prepared fully to enjoy its use. On the other hand, we have done comparatively little for the increase of consumption. The possibility of such increase by the poor has been enlarged but little, while the inclination of the rich therefor has been greatly restricted. Under such circumstances, what wonder that production has run ahead of consumption—what wonder that general over-production, as an actual existing fact, has finally been reached?" His views of the means of remedying the conditions he depicts are quite as indefinite as those of most of the writers who have given attention to the subject. After dismissing several suggestions as remedies to be avoided rather than sought for, he falls back upon strikes and boycotts, but can not conceal an apprehension that they too—as they have done—will prove to have the action of a boomerang.

Astronomy by Observation. By Eliza A. Bowen. New York: D. Appleton & Co. Pp. 90. Price, $1.

By observation mankind learned all the astronomy it knows, and came to the theories it holds as correct. By observation, Miss Bowen believes, pupils in schools can to-day be best taught to learn the phenomena of the heavenly bodies, and be guided to the deduction of the principles on which they depend. A brief article on "Astronomy in High Schools," which the author published in the "Monthly" of January, 1882, describing her experiences with her pupils in the method of observation, will furnish the key to this book, which has grown out of these experiments. "My object," she then says, "has been to gain for my pupils from this study, not merely knowledge, but all the mental discipline it could afford. In order to accomplish this, I have made it an invariable principle to make them do all the observing, all the thinking, possible. They have watched the heavenly bodies to discover their appearance and motions, and then I led them on to discuss the causes. It has been genuine inductive study, so far as it has gone. My own work seemed very simple; but it occasioned me a great deal of observation, thought, and study. I have simply kept them on the track." This book is intended to aid other teachers in the performance of that duty, and to help the pupil too. In it, an efficient, easy, well-tried plan for teaching the constellations is described, the use of which will obviate the necessity of a teacher doing work out of school-hours, by enabling students to become independent observers; careful directions are given when, how, and where to find the heavenly bodies; and their motions are described in the order in which they can be seen by an observer, and in familiar language. Thus the student is excited to thought. He is prompted to see for himself, and then can not avoid the inquiry what it all means. In order that his inquiries may take the right direction, facts are in the book stated first, and theory is given afterward, as a deduction from the facts. The selection of subjects for the student's thinking is a little different from that of other school astronomies. The general principle governing it is to make the student understand what he can see. Miss Bowen has also sought to make her book of use to those instructors who have little or no practical knowledge of the science, but who would improve if the text-book were a guide to observation, and to the increasing class of young people out of school who would study the stars for themselves if they had suitable leading.

A Farmer's View of a Protective Tariff. By Isaac W. Griscom. Woodbury, N. J.: Published by the author. Pp. 53.

It would be hard to find in the literature of political economy an author who has written about the protective tariff with a clearer head than this "farmer." The basis of his thesis is that, agriculture having been recognized on all sides as by far the most important business interest in the nation, it has followed that one of the main arguments in favor of maintaining a protective tariff has been, that it would aid agriculture by creating increased home consumption with steady and remunerative prices for the farmer's products. "This looks very well, to be sure, as a theory, but, after twenty years' experience, the agriculturist finds himself getting no more (a good deal less, in fact) for his products than before the civil war; and, with his necessary expenses very much greater than then, he naturally begins to wonder if there was not something wrong in the original calculation." Mr. Griscom then proceeds to show that there was something wrong there, and wherein it lay.

The Rear-Guard of the Revolution. By Edmund Kirke. New York: D. Appleton & Co. Pp. 317. Price, $1.50.

This work presents a chapter in American history of which not so much is known as ought to be, but which, if the view the author takes of it is correct, is of exceeding importance. It embodies the history of three of the pioneers of the central region of the United States, who, "clad in buckskin hunting-shirts and leading inconsiderable forces to battle in the depths of a far-away forest, not only planted civilization beyond the Alleghanies, but exerted a most important influence in shaping the destinies of this country." They were John Sevier, Isaac Shelby, and James Robertson, "all of them characters worthy of the most heroic ages, and so exactly adapted to the work which had to be done that the conclusion is irresistible that they were, like Lincoln and Washington, 'providential men.' . . . Their slender forces trod silently the Western solitudes, and their greatest battles were insignificant skirmishes, never reported beyond the mountains; but their deeds were pregnant with consequences that will be felt along the coming centuries." These ascriptions are justified, in the author's mind, by the conclusion at which he has arrived from his studies, that two of the men thrice saved the country by thwarting the British plan to envelop and crush the Southern colonies, and by turning the tide of the Revolution at King's Mountain; and that after the Revolution the three, acting together, frustrated the design of Spain to dismember and weaken the Union by causing the erection of a separate republic in the country between the Alleghanies and the Mississippi. The materials for the history were gathered principally from old settlers of East Tennessee and Western North Carolina. The present volume does not tell the whole of the story, but is to be supplemented by a second, in which events will be brought down to the deaths of Sevier and Robertson.

Insects affecting the Orange. By H. G. Hubbard. Washington: Government Printing-Office. Pp. 220, with Plates.

Mr. Hubbard was employed as a special agent of the Entomological Division of the Agricultural Bureau, in Florida, and devoted his time for nearly four years in studying the insects that affect the orange, and in practical experiments to counteract their injuries. "It is but uttering a deserved compliment," Dr. Riley remarks, "to say that the practical results of his labors have been most satisfactory, and mark an important era in the history of orange-growing in the United States." The trees of the citrus family are particularly subject to the disastrous ravages of various species of scale insects, which not infrequently thwart all effort to raise a grove. It is to these that the present report is chiefly devoted, and to their control that the greatest efforts were made. The practical object—that of helping the orange-grower in the warfare which must be waged with insect foes—has been held foremost in the preparation of the report; but scientific information and more complete descriptions are given, or referred to, for those who want fuller or technical information.

Ottawa Field Naturalists' Club. Transactions No. 6. Ottawa, Canada. Pp. 130, with Plates.

The club is now incorporated, and returned, for 1884–'85, 168 members. Of the year's collections, mention is made of 920 plants, 208 species of shells, 198 of birds, 48 of fishes, and 1,004 of insects. It is suggested in one of the special reports, recommending the local study of natural history, that "were local societies, instead of wandering aimlessly among the paths of natural science, to devote themselves to this work, . . . there would soon be accumulated a fund of information more perfect and complete than by any other method. The inaugural address of President H. Beaumont Small points out to the members the fields of investigation which they may find in the several orders of the animal kingdom. It is followed by papers on "The Canadian Otter," by Mr. W. P. Lett; "The Minerals of the Ottawa District," by Mr. C. W. Willimott; "Terrestrial Mollusca of Ottawa," by Mr. F. R. Latchford; "Wheat, with Especial Reference to that grown in the Ottawa District," by Mr. William Scott; "Our Saw-Flies and Horn-Tails," by Mr. W. H. Harrington; "Our Trenton Fossils," by Mr. W. R. Billings; "The Geology and Paleontology of Ottawa," by Mr. H. M. Ami; Reports of the Paleontological, Botanical, Conchological, Entomological, Ornithological, and Zoölogical Branches; and an Abstract of Meteorological Statistics, by Mr. A. McGill.

Archivos do Museu Nacional do Rio de Janeiro (Archives of the National Museum of Rio de Janeiro). Vol. VI. Rio de Janeiro. Pp. 560, with numerous Plates. Conférence faite au Muséum National, en Présence de LL. MM. Impériales (Lecture delivered at the National Museum, in the Presence of their Imperial Majesties). By Dr. Ladisláu Netto. Rio de Janeiro. Pp. 28.

The volume of the "Archivos" relates to the ethnology, anthropology, and archæology of Brazil. Among the papers it contains are "Contributions to the Ethnology of the Valley of the Amazons," by C. F. Hartt; "The Man of Sambaquis, a Contribution to the Anthropology of Brazil," by Dr. J. B. de Lacerda; "New Craneometrical Studies on the Botocudos," by Dr. J. R. Peixotto; and "Investigations upon Brazilian Archæology," by Dr. Ladisláu Netto. These papers are richly illustrated with colored and monochrome plates, and engravings inserted in the text. Of particular interest is a series of plates of comparative symbolical characters, which show the similarity of the symbols for corresponding objects in the Márajo (of Brazil), Mexican, Chinese, Egyptian, and Indian writings. The lecture of Dr. Netto, who is Director-General of the National Museum, presents a summary in the French language of the results of archæology in Brazil, and is devoted largely to the explanation of the principal features of the papers contained in the "Archivos."

Lorenz Alma-Tadema: His Life and Works. By Georg Ebers. New York: William S. Gottsberger. Pp. 94, with Thirteen Plates.

Alma-Tadema—a Frisian by birth—is one of the foremost of English painters, and an artist whose style—except as he may have had imitators—is unique. His favorite themes are the severe classical and mediæval. Dr. Ebers is his close friend, and has undertaken to present this review of his life and works under the impulse of the thought that "he who knew him so well as a man also understood him as an artist, and would probably be able to give a faithful picture of his life." The illustrations are representations of some of the artist's most famous works.

Lettre à Monsieur Ernest Renan à propos de l'Inscription Phénicienne Apocryphe (Letter to M. Ernest Renan respecting the Apocryphal Phœnician Inscription). By Dr. Ladisláu Netto. Rio de Janeiro. Pp. 35, with Plates.

In 1872 Dr. Netto submitted to the Historical, Geographical, and Ethnographical Institute of Brazil a pretended Phœnician inscription which was said, by one Joaquin Alves da Costa, to have been found by his slaves on one of his estates. It was afterward ascertained, and Dr. Netto was convinced of the fact, that the inscription was false. In this letter, addressed to M. Renan as "one of the most illustrious Orientalists of modern times," the author explains his relations to the matter, for which he has been subjected to unfavorable criticism, but which appear to have been entirely honest.

Kidnapped. By Robert Louis Stevenson. New York: Charles Scribner's Sons. Pp. 324. Price, $1.

This story—of the Highlands and the Highland life of Scotland at a period when the land was tormented by contentions—sets forth the adventures of David Balfour in the year 1751; "how he was kidnapped and cast away; his sufferings in a desert isle; his journey in the wild Highlands; his acquaintance with Alan Breck Stewart and other notorious Highland Jacobites; with all that he suffered at the hands of his uncle." The author is known as a story-teller of vigor and dramatic force, and as vivid in description; and the picture on the cover, of a Highlander jumping over a waterfall, promises exciting times to the reader.

Fourth Report of the United States Entomological Commission. By Charles V. Riley. Washington: Government Printing-Office. Pp. 147, with Maps and Plates.

This report relates to the cotton-worm, concerning which it embodies the final report, with a chapter on the boll-worm. The investigation of the cotton-worm was begun in 1878, and continued during four years; and the results of it, according to the showing here given, have been fruitful. The history of the subject and the various matters relating to the worm, its depredations, and the treatment of the pest, are gone into with considerable elaboration. In the successive chapters of the report are considered the natural history of the insect; its past marked appearances and the remedies proposed, chronologically arranged; the distribution and anatomy of the *Aletia;* the cotton belt, its characteristics and peculiarities; the influence of soil, weather, etc., upon the first appearance of the worms and their increase and destructiveness; the natural enemies of the insect; means of destroying the worm; machinery and mechanical devices adapted to that purpose; the literature of the subject; insects liable to be confounded with the true cotton-worm; and the boll-worm.

The Mystery of Pain. By James Hinton, M. D. Boston: Cupples, Upham, & Co. Pp. 120.

From the introduction to this book by Dr. J. R. Nichols, we learn that its author was for many years a sufferer from despondency, and a victim to much mental and physical pain, and was also a deeply religious man. He himself employs, to illustrate the reason of pain, the supposition of an island, the climate of which is so unhealthy that the inhabitants are constant sufferers from rheumatism, so that walking would be painful to them. They would call walking an evil. "But in this their thought would be false. They would be feeling a good thing painful because they did not understand their own condition. And if it could be explained to them that the cause of their pain was not anything bad in walking, but only their own disease, that itself would be a gain to them. . . . Now, this is the idea I have tried to explain in this little book; namely, that things which we have inevitably called evil may yet be truly good. My thought was that all which we feel as painful is really giving something that our fellows are better for, even though we can not trace it; and that giving is not an evil thing, but good, a natural delight and good of man; and that we feel it painful because our life is marred." To quote from Dr. Nichols again, the cure for pain which Dr. Hinton suggests "rests on a religious basis; and hence has no meaning or significance to those destitute of religious faith."

Observations on Volcanic Eruptions and Earthquakes in Iceland within Historic Times. Translated and condensed by George H. Boehmer. Washington: Government Printing-Office. Pp. 46.

This paper has been prepared in connection with the Smithsonian Report for 1885, and is abridged from a larger paper by Th. Thoroddsen. Although the volcanoes and hot springs of Iceland are treated of in a work written at about the middle of the thirteenth century, in which some superstitious ideas are advanced as to their origin, and an eruption is recorded in the present paper which took place about A. D. 900, the geology of Iceland was not thoroughly studied till the beginning of this century, and is still little known. The active volcanoes of Iceland are described as in eight groups of from one to five volcanoes each. Within historic times, eruptions have occurred at about twenty different places. Among the large volcanoes, Hecla occupies the first place, with twenty-one eruptions; while others follow, with twelve or thirteen, ten, six, and one each. The largest numbers of eruptions took place in the fourteenth century (thirteen), and in the eighteenth century (fourteen). The earthquakes have been in direct connection with the eruptions. A copious bibliography is appended to the paper.

Cassell's National Library. Edited by Professor Henry Morley. New York: Cassell & Co. Thirty-five weekly volumes to date, averaging 192 pages each. Price, 10 cents each.

This library gives more for the money—meaning by more, actual value rather than quantity—than any other popular series that is published. It gives in clear, open type, suitable to all eyes that can read at all, and in a shape convenient for the pocket, selections from the best literature of all ages, and particularly from English literature, in works that are complete in themselves. The books have all been named in our monthly acknowledgments of "Publications received," and it is hardly necessary to say more of them particularly than to refer to the titles and authors as there given. In the list are represented by their best works such writers as Silvio Pellico, Lord Byron, Benjamin Franklin, Izaak Walton, Plutarch, Herodotus, Lord Bacon, Horace Walpole, Dean Swift, Sir Walter Scott, Sheridan, Goldsmith, Sir John de Manndeville, Shakespeare, and other authors whose names are fixed in the world's literature, but whose works are not easily got in as accessible form as that in which they are here presented.

Historical Society of Southern California. Los Angeles, January, 1886. Pp. 43.

We do not find anywhere in this report a line from which we may form a conception of the age of the society. Lists of officers for 1885 and 1886 are given, from which we are assured that it is at least about two years old; but it would be interesting to know more exactly how long it has been at work encouraging the study of the history of that district of romantic story in which its peculiar field lies. The address of the retiring president informs us that it enjoys a credit balance which it is hoped may be the beginning of a building fund, and that its monthly meetings are regularly held and attended with lively and interesting discussions. The retiring president, Mr. John Mansfield, recommended a division of the society into sections, embracing various branches of scientific research and history proper, and the admission of the teachers and pupils of the Normal and High Schools to its privileges. These recommendations are approved and made more definite by the new president, Mr. Isaac Kinley, who would also embrace art within the scope of the society's objects. Mr. Kinley urges energetic industry in the pursuit of the special historical work, while those who were not only the spectators but the makers of the history are still among them, and because the records are in a perishing condition. "The old Mission buildings are crumbling into soil, valuable old manuscripts are being gnawed into illegibility by the tooth of time." Besides the two presidents' addresses, the report contains papers on "California in the Eighteenth Century," as it was described by Father Francis Palon, founder of the Mission Dolores, by J. Adam; "The Glacial Period," by Professor Ira Moore; "Trap-door Spiders," by Miss Monks; and "North American Lakes," by Isaac Kinley.

A Study of Primitive Christianity. By Lewis G. Janes. Boston, 1886. Pp. 319. Price, $1.50.

This book is the fruit of many years of study, issuing in a series of lectures for the benefit of "The Association for Moral and Spiritual Education" connected with the Second Unitarian Church in the city of Brooklyn. The point of view is Unitarian as regards theological conceptions of the personality and mission of the Nazarene; but the author is a sincere lover of the character of Jesus, and disposed to do full justice to the influence and value of his teachings. Dr. Janes is evidently a thorough scholar, and one can not fail to be impressed with the care, the honesty, the faithfulness, the impartiality, the love of truth, the conservatism exhibited throughout this admirable volume. Quite irrespective of the author's conclusions upon special disputed points, no one can gainsay that his work is, in the language of the pastor of his church, who writes a preface, "a wonderfully clear and strong expression" of the facts which his study has determined; and that to this study he has brought "a singularly just and patient mind." We commend the book, not only to Unitarians, but to all who are willing to trace, or to see traced in a masterly manner the operation of natural causes, of race, politics, and social conditions generally, upon the rise and progress of Christianity.

It is not within our province to enter upon a critical discussion of either the theological or historical questions which this work involves; but it is very interesting to note the method which Dr. Janes pursues, and observe his theory of the development of the organized Christian system. He follows its course up to the point when it became the Roman state religion, and his conclusions are, that it "arose by a natural process of evolution out of pre-existing systems to complete the overthrow of the prevailing though effete polytheistic *cultus*, and to supplement the narrowness and partialism of the decaying ethnic religions by the principles of universalism and human brotherhood." The influences determining its various phases from the simple altruistic teaching of Jesus to the formidable political power which it came to wield in its union with the state are thoroughly studied and set forth effectively in the method of truly scientific exposition.

The author distinguishes sharply between the Jesus of the first three gospels, the "Triple Tradition," and the Jesus of the fourth. The "Triple Tradition," in his judgment, represents the man as he really was in life, "a simple, noble, manly personage, full of intense conviction and prophetic enthusiasm, who moves naturally and freely in his Hebrew environment." The fourth Gospel, however, presents the Great Exemplar with the incumbrances of the many myths of Aryan and Egyptian thought; and to separate the Christ of actual history from the legendary Christ, to whom have been attached these ancient myths of the East and of Egypt, is one of the main purposes of Dr. Janes's critical study. For instance, the great solar myth is indicated as the source of the narrated miracles of cure, of the doctrine of the Logos, and again of the final miracle of the resurrection.

The religion of the future, Dr. Janes believes to be, "the true religion of humanity," which was the simple, unalloyed teaching of Jesus of Nazareth—a very different thing from the Christianity triumphant which was exemplified in imperial Rome—"a compromise with pagan power and sacerdotalism, a hybrid product which the Nazarene would never have recognized as the child of his simple enthusiasm for righteousness, his devotion and self-abnegation, his suffering and agony, his poverty and supreme sacrifice." This religion of the "brotherhood of man," and with it the trustful acceptance of the beneficence of the order of Nature, is the rational fulfillment of Jesus's doctrine of the "fatherhood of God."

First Lessons in Zoölogy. By A. S. Packard. New York: Henry Holt & Co. Pp. 290. Price, $1.

In preparing this manual, the author has had in view the excellent plan, which has been adopted in some museums, of placing near the entrance "Epitome Collections," or a series of examples of the principal classes of the animal kingdom, so that the visitor may go into the main collection prepared with an idea of its logical arrangement. The book differs from the author's two other text-books in zoölogy in that it treats of still fewer examples or types; that fewer technical terms and names are used; that it seeks to lead the student from the facts to the principles, without tiring him with formal general statements; and that the subject as a whole is given in somewhat smaller compass—all being in the direction of better adaptation to elementary instruction. The importance of studying from specimens, fresh and alive, using the book as an aid to that study, and not relying upon it alone, is insisted upon; and the pupil is exhorted to go out, look at the animals where they live, and learn how they live.

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POPULAR MISCELLANY.

Low Water in Wells and Typhoid Fever.—Dr. Henry B. Baker, of Lansing, Michigan, supposes a close relation to exist between typhoid fever and low water in wells. The diagrams which he presents in his paper of the prevalence of sickness from typhoid fever in Michigan, and the depth of the earth above the ground-water in the wells during six successive years, seem to show that, beginning with June in each year, the sickness-curve follows more or less closely the well-water-curve. The author believes that one of the causes, probably the principal cause of sickness, is the contamination of the water by the drainage from stable-yards, privy-vaults, and cess-pools, which reaches the wells more directly when the water in them is low, and forms in them stronger solutions than when it is high. On the other hand, the curves in several years, from January to June, show no such correspondence. The difference in results is explained by the frozen condition of the ground in the winters when typhoid did not prevail; a condition which, while it tended to reduce the quantity of water in the wells, at the same time prevented percolation from the surface sources of contamination. The fever was more prevalent in the open winters when percolation was not thus impeded. Corroboration is given to these views by a remark made by Dr. Foster Pratt, of Kalamazoo, at the meeting of the American Medical Association in June, 1874, that typhoid fever was unusually prevalent in Kalamazoo in a certain year in the autumn, at about the time the water in the wells was very low, and some wells became dry.

Professorships of Physical Geography.—Professor H. N. Mozeley, in an address at the Royal Geographical Society's recent exhibition of geographical appliances, made a plea for the establishment in the English universities of chairs for teaching physical geography apart from geology. He quoted from letters which he had received from German professors who are teaching under a plan similar to the one which he proposes. Among them is Professor Kirchhoff, of Halle, who said: "It is, no doubt, correct that geology, in just the same way as geography, is concerned with the earth and all its various parts. But the point of view on either side is different. For example, while I am delivering in Halle during four successive semesters the course on geography, Professor von Fritsch and two colleagues are lecturing to almost entirely different audiences on mineralogy, crystallography, geology, and paleontology. In summer, Professor von Fritsch arranges excursions for geological purposes, and many of the students take part in these, because a problem of great geographical importance is able to be solved during these excursions, namely, the explanation of the form of the land-surface as resulting from its composition, and by means of the history of its development. The two sciences do, indeed, touch one another in what is termed superficial geology, but from this zone of contact they stretch wide apart from one another. Geology discusses not only the developmental history of the earth in the Quaternary period, a matter which concerns the geographer quite as much as the geologist, but it discusses also that of the most remote periods of the earth's antiquity, investigates the petrographic structure and the organic life of every formation, subjects which hardly concern the geographer at all. On the other hand, geography has to deal not only with the land-surface and the waters, but also with climate, the flora and fauna, and human inhabitants, both of the earth as a whole and of each separate country, confining its view to the present only—that is to say, to the Quaternary period. It might as well be said that the existence of history as a subject at universities rendered geography unnecessary, because it also has to do with the entire earth's surface."

Arsenic in Wall-Papers.—Professor H. Carmichael presented some important facts to the American Association in his paper on "The Quantity of Arsenic contained in Wall-Papers." Scientifically speaking, he said, probably no paper in the market is strictly free from arsenic, for faint indications of it may always be discovered when specially delicate tests are applied. For the present purpose, papers containing less than one fiftieth of a grain of white arsenic to the yard are said to be free. Thirty-one samples of paper, which were regarded as average ones, yielded on analysis an average of 2·2 grains to the square yard. It was impossible to classify the papers so that their prevailing colors would bear any simple relation to the amount of arsenic discovered. A paper with green ground, in which arsenic might have been suspected, was the only one in the lot entirely free therefrom, while a paper nearly white contained a quarter of a grain. Papers "warranted strictly free from arsenic" by the manufacturers also contained notable quantities. In general, arsenic is more abundant in the figure than in the ground, and in brilliant than in the light, monotoned papers jus- now in fashion. Carmine red is particularly distinguished by the amount of arsenic which it usually yields. This is to be attributed to the arsenic employed in the manufacture of aniline red, the common red coloring-matter of paper, and from which, in its manufacture, the aniline fragment is imperfectly freed. This same red dye, with its arsenical impurity, is unfortunately largely employed, on account of its resemblance to the more costly cochineal, in coloring worsted and woolen underwear. It may be easily distinguished from the latter by the readiness with which it imparts its color to wash-water or the skin with which it comes in contact. Unfortunately, there is no guide in the selection of papers free from arsenic except chemical analysis, and no security to the purchaser unless by a prohibitory law duly enforced.

The French Association.—The French Association for the Advancement of Science met in its fifteenth annual session at Nancy, August 12th, and was opened with an address by the president for the year, M. Friedel, the chemist, whose subject was "The Progress of Chemistry and Mineralogy." M. Friedel preceded his address with the announcement that the negotiations for a union with the *Association Scientifique*, had been brought to a happy conclusion, and only a single detail of formality had to be gone through to make the union an accomplished fact. The object of the Association was defined to be, to attract the largest number possible of their fellow-citizens to high scientific culture; not to vulgarize science, or bring it down by taking its true character away from it; but to unite those who cultivate the highest science, and group around them those persons who, without ascending to the summits, wish, at least, from medial regions, to follow with their eyes the traveler going up, through the obstacles, from peak to peak, without ever reaching the last one. In his conclusion, he recommended as another purpose, which they could all seek without provoking jealousies, the advancement of the intellectual and moral glory of their country. "Science," he said, "is a marvelous agent of industrial progress, and those labor under a false inspiration who regard it as a superfluity of an aristocratic civilization. Economic failures must soon remind them that the industry of routine has now lived its day, and that that only is vital which rests closely on the knowledge of the laws of matter. Science is no less favorable to moral development. How the assiduous search for truth, whether in the world of matter or in that of extent and quantity, elevates the mind and fortifies the heart! How much ought the comparison of the little that we know with the infinitude that we do not know to contribute to make us modest!" Another advantage of helping the progress of science is that, while we differ on so many other questions, we can be one in that. M. Collignon, the secretary-general, made the annual report of the history of the Association during the year. An address of welcome was made by the Mayor of Nancy, who said that they desired to create there a great center of French science, to compensate for what they had lost at Strasburg. An important discussion took place, in the Agricultural Section, on wheat-production, in which the competition of India was acknowledged to be formidable, and threatening to become more so. M. Cartaillac, in a paper in the Anthropological Section, on primitive burial rites, maintained that the custom of letting corpses entirely decompose before giving them a definitive burial had been a very prevalent one. Of the excursions, one contemplated to Mount Douon, which is in German territory, was prevented by the jealousy of the German officers, who were not acquainted with the nature of the Association, and feared it might be a political body. The meeting of the Association for 1887 is appointed to be in Toulouse, and that for 1888 in Oran, Algeria.

Regimen for Inebriates.—Dr. Joseph Parrish, in his address as president, at its last meeting, of the American Association for the Cure of Inebriates, analyzed the English system for the care of persons of this class as exemplified in the "Habitual Drunkards Act," and described the five retreats that have been licensed under the act, together with several retreats under the voluntary system which have not taken out licenses. The licensed retreats are: Dalrymple House, Rickmansworth; Tower House, Westgate-on-the-Sea; Old Park Hall, Wallsall, Staffordshire; High-shot House, Twickenham; and Colman Hill House, Halesowen, Worcestershire. These institutions gave good accounts of their operations, but seemed to regard themselves, generally, as still in the experimental stage. The reports from the voluntary retreats are more varied, and some of them furnish suggestions. The "sister in charge" of one house, a woman's home of the Church of England, believes that "one year is necessary for a cure. To tide over the broken-down condition, and remove physical disability, requires at least six months, and the last six months are needed to restore and establish the moral and religious character." Dr. James Greenwood, whose institution is of twenty-five years' standing, says, as a result of his experience, that "bad cases of confirmed inebriety can only be cured by compelling total abstinence for a period of not less than twelve months." He has been tolerably successful, though some cases have taken two years to cure; "but from six to twelve months is usually sufficient." He can more readily obtain patients and induce them to place themselves under treatment by considering them merely as visitors come to reside with him for a time as a private medical man. Dr. James Stewart, late surgeon in her Majesty's navy, says: "Having attendants is a choice of evils; I do not have them. To place a man of intelligence and culture in the care of an ignorant and possibly a rude hireling, is therapeutically wrong. All sources of irritation should be avoided. . . . I consider the first three months of a patient's residence should be given to physical renovation. The second three months should be employed in learning to enjoy life without the usual accompaniment of alcoholic stimulants. . . . The third three months, they should learn to do just as sober and upright people do—to live like other people—and, the longer they continue to accommodate themselves to the new life, the better for them and for all concerned. . . . Rest, abstinence, and tonics, establish a cure." Two rules, recognized as cardinal by all the retreats and homes but one, are—that no intoxicating drink shall be introduced on the premises under any circumstances, unless ordered as a medicine by the medical superintendent; and that no drug of any kind shall be taken by the patients except with the consent of the physicians.

How Water becomes Oxygenized.—In a paper on "The Relations of Air and Water," which he read before the American Association, Professor W. H. Pitt observed that "water falling through air, as, for instance, a small stream poured from a pitcher into a basin of water, will carry down air with it beneath the surface. The air is carried down by adhering to and mechanically mixing with the falling water. Now, as oxygen has greater adhesive property for water than nitrogen, the proportion of these two gases carried along by water in its fall is undoubtedly different from that which exists in the common atmosphere. Water, then, has a selective affinity for oxygen and very little comparatively for the inert nitrogen of our atmosphere. An application of this principle on a magnificent scale may be seen in the great storms of water falling from the clouds to the earth. We may then expect, for a short time at least, and in appreciable quantities, after a rain, a richer condition of the air in oxygen, which of course would have a corresponding effect upon all substances, organic or inorganic, susceptible of oxidation. It is probable, also, according to this theory, that the outward and upward rush of air at Niagara Falls, with the seething foam, is more than normally rich in oxygen.

Surface-Currents of the Ocean.—Some experiments have recently been made by Professor G. Pouchet, under the patronage of the Prince of Monaco, with relation to the superficial currents of the ocean. The purpose was to determine the existence of a current that might carry warm weather to the coast of Europe. Ten copper spheres, a foot in diameter, twenty kegs, like beer-kegs, and a hundred and fifty well-corked bottles, all bearing requests in several languages, to be taken care of by the finder, were carried to the Azores, and dropped on the 27th and 28th of July, 1885, on a line about one hundred and seventy miles long and running 14° north by east. It was supposed that, if any of the floats reached the coast of Europe, it would be at between 40° and 50° north latitude; but none of them have yet been seen in those regions. Three of the floats were taken up after a travel toward the east, in which they had at the same time inclined toward the south. Two bottles and one keg were found at the Azores; the bottles in positions which showed that they had taken fifty-three days to travel a distance of four hundred and twenty miles, and the keg where it seemed to show that the floats were continuing their course toward the south. The positive though partial results thus obtained appear to establish the fact that, from the latitude in which the floats were thrown overboard, not a drop of the surface-water of the Atlantic reaches the coast of France.

Milk for Infants.—Dr. T. Lauder Brunton has some important remarks, in his paper on "Poisons formed from Food," on the quality of the milk that is given to infants, and the dangers arising from carelessness in using it. Milk, he says, "may apparently be quite sweet at the time it is given, and yet it may really be 'on the turn,' as the term is. When swallowed by the infant, it may rapidly become sour and disagree, while a portion of the same milk, especially if kept cool, may appear to continue sweet for some hours afterward. It is highly probable that not the least advantage possessed by milk drawn from the breast, over that given by a bottle, is that the former is free from bacteria with which the latter is apt to be contaminated. Both may appear equally sweet when administered to the child, but the organisms present in the baby's bottle will continue their action after the milk has been taken, and render it liable to produce vomiting and purging, which are symptoms of poisoning by putrefactive alkaloids. The risk of contamination is much greater when a bottle with a long tube is used, for the bacteria readily find a lodgment in it; and it is to be remembered that not only do the bacteria present in the milk at the time it is swallowed continue to decompose it in the stomach, but they continue to multiply, so that, if even a few are present in the milk when it is taken, they may within a short time multiply greatly, and produce extensive changes in the food if they find conditions favorable to their growth in the intestinal canal."

The Dakotas and their Holy Stones.—Mr. H. C. Hovey gave before the American Association a description of "Eyah Shah," or Red Rock, a sacrificial stone of the Dakotas, which is near St. Paul, Minnesota. It is a well-known custom among the Dakotas to worship the bowlders that are scattered among the hills, valleys, and prairies where they may dwell. "When a Dakota was in perplexity or distress, he would clear a spot from grass or brush, roll a bowlder upon it, streak it with paint, deck it with feathers and flowers, and then pray to it for needed help. Usually when a stone had thus served its purpose, it was no longer regarded as a sacred object, but might be disposed of in any way that suited the savage whim. But the peculiarity of the sacrificial stone now described is that from year to year and from one generation to another it was a shrine to which pilgrimages were made and where offerings were laid. Notwithstanding the significance of its name, the stone is not naturally red, but is merely an extremely hard specimen of hornblende-biotite-granite, about five feet long and three feet wide. It is also called "Waukau," or a mystery. "The hunting-ground of the clan claiming the altar was upon the St. Croix River; and invariably before starting on an expedition they would visit Eyah Shah and leave an offering of gayly painted feathers, or a duck, or a goose, or a haunch of venison, and after a few simple ceremonies they would go on their way. But twice a year the clan would meet more formally, in order to paint the stone, which they did with vermilion, or, as some say, occasionally with the blood of their enemies which had been saved up for the purpose. When the painting was done they would trim the bowlder with feathers, flowers, and other ornaments, and dance about it before sunrise, with chants and prayers for successes from the mysterious spirit of the rock. The rock was last known to have been visited in 1862, just before the massacre, although the stripes have been renewed, possibly by the white men. "By the compass, Eyah Shah lies exactly north and south. It is located just twelve paces from the present river-bank. The north end is ornamented by a design representing the sun—a rudely drawn face surrounded by fifteen rays. These markings are interesting, because, if not actually made in their present condition by the Indians, they were evidently meant to reproduce their original work."

The Order of Children's Studies.—In a paper on this subject read before the Education Society, Mrs. Bryant says that the order of studies should depend both on the order of the development of faculty and the order of logical dependence in knowledge. Subjects become interesting to a child as his intellect develops a capacity for dealing with them; hence, the order of interest in studies for children should be taken as a clew to the natural order of studies for them. Children are interested in the superficial aspects of Nature. Nature-knowledge should be one of their first studies, developing gradually into natural science as intellect ripens and the age of reason draws near. Children are also interested in social objects so far as these appeal to their rudimentary faculties of emotion and imagination. History and literature of the elementary kind should find a place among their studies, and thus preparation may be made for a scientific study of the same subjects later on. The mother-tongue is profoundly interesting to children, and they are, to some extent, interested in foreign languages, the acquisition of which is at the most quite possible to them. Hence the study of the English and of a foreign language may take an early place in the curriculum. The increasing complexity and the increasing inwardness which characterize mental development throughout bring about at last that capacity for and impulse in search of general knowledge which distinguish the adult from the childish mind. Then the order of studies is dominated by the logical sequence of sciences.

Prehistoric Monuments in Southeastern Africa.—A feature of the region of Eastern Africa south of the Zambesi, which has hitherto escaped the attention it deserves, is the evidence that is cropping out day by day, in the shape of extensive ruins, of the existence of a prehistoric civilization and an ancient flourishing state in the country. The ruins are of such a character as to indicate the former existence, not merely of one or two cities, but of a considerable dominion. Ruins of cities have been discovered which have stood, if the difference in climate be considered, nearly as well as the most enduring monuments of Egypt, and better perhaps than those of Assyria, the wear and tear of time. In the imperfect state of our knowledge of the country, it is impossible to fix upon any particular mass of ruins and say that it was the chief city of the ancient state. The ruins of Zimbabye are of great extent, and most remarkable for the strange shapes they present as well as for their enduring structure. Walls twelve feet thick at the base, and tapering upward to a height, even now, of thirty feet, constructed wholly of small hewed blocks of granite, put together without mortar, and in which are imbedded blocks of stone eighteen and twenty feet in length, apparently to support a gallery, sufficiently testify to the ingenuity and industry of their builders. North of these, about Manica, many ruins are to be found, and no less than three hundred and fifty miles west of these again masses of masonry are to be seen, like the others described in solidity and singularity of shape. No inscriptions have been discovered and verified, but a forty-years resident, a native of Portuguese India, who has married one of the queens of the country, says there are numerous inscriptions about Manica, for which his descriptions indicate a cuneiform character. Much may be said in favor of Consul O'Neill's theory, that the ruins are the remains of ancient Phœnician settlements.

"Hereditary Stature."—Mr. Galton has completed "to a well-defined resting-place" his investigations of hereditary stature, and has declared his conclusions in a kind of a general rule. The main problem which he had in view was to solve the question: given a man of known stature, and ignoring every other fact, what will be the probable height of his brothers, sons, nephews, grandchildren, etc.; what will be their average height; and what proportion of them will probably range between any two heights we may specify? From his measurements, which were made by a method that he calls "almost absurdly simple," he found that for every unit that the stature of any group of men deviates upward or downward from the level of mediocrity (five feet eight inches and a quarter), their brothers will, on the average, deviate only two thirds of a unit, their sons one third, their nephews two ninths, and their grandsons one ninth. In remote degrees of kinship, the deviation will become zero; in other words, the distant kinsmen of the group will bear no closer likeness to them than is borne by any group of the general population taken at random. The *rationale* of the regression from father to son toward the level of mediocrity is due to the fact that the child's heritage comes partly from a remote and numerous ancestry, who are, on the whole, like any other sample of the past population, and therefore mediocre, and partly only from the person of the parent. Hence the parental peculiarities are transmitted in a diluted form, and the child tends to resemble, not his parents, but an ideal ancestor who is always more mediocre than they. Every one of the many series of measurements with which Mr. Galton has dealt in his inquiry has conformed with satisfactory closeness to what is called the "law of error." He knows of scarcely anything so apt to impress the imagination as this law. "It reigns with serenity in complete self-effacement amid the wildest confusion. The huger the mob and the greater the apparent anarchy, the more perfect is its sway. Let a large sample of chaotic elements be taken and marshaled in order of their magnitudes, and then, however wildly irregular they may seem, an unsuspected and most beautiful form of regularity appears to have been present all along. Arrange the statures side by side in order of their magnitudes, and the tops of the marshaled row will form a beautifully flowing curve of invariable proportions; each man will find, as it were, a preordained niche, just at the right height to fit him, and, if the class-places and statures of any two men in the row are known, the stature that will be found at every other class-place, except toward the extreme ends, can be predicted with much precision. It will be seen, from the large values of the ratios of regression, how speedily all peculiarities that are possessed by any single individual to an exceptional extent, and which blend freely together with those of his or her spouse, tend to disappear. A breed of exceptional animals, rigorously selected and carefully isolated from admixture with others of the same race, would become shattered by even a brief period of opportunity to marry freely. It is only those breeds that blend imperfectly with others, and especially such of these as are at the same time prepotent, . . . that seem to have a chance of maintaining themselves when marriages are not rigorously controlled. . . . It is on these grounds that I hail the appearance of every new and valuable type as a fortunate and most necessary occurrence in the forward progress of evolution."

How Inventions are evolved.—Vice-President Chanul, in his address before the Mechanical Section of the American Association, considered what might be called the evolution of inventions. Nothing, he said, is more remarkable than the multitude of minds and facts which are required for the perfecting of even a simple machine, or how little the last man may need to add to complete the invention. Facts and natural laws, known for years as curiosities, are taken up by some inventor, who fails in the attempt to render them of practical use; then a second genius takes hold, and, profiting by the mistakes of the first, produces, at great cost, a working machine. Then comes the successful man, who works out the final practical design, and, whether making or losing a fortune, yet permanently benefits mankind. This course is exemplified in the address by the relation of the growth of the steam-engine; and so with other inventions: the steamboat was being developed from 1760 to 1807; the locomotive from 1802 to 1829; the telegraph, from 1729 to 1844; the sewing-machine, with its two thousand patents, from 1790 to 1860; and the reaping-machine for seventy-five years—the last successful man adding generally but little to the work of his forerunners. The rule has been that "the basis of success lay in a thorough acquaintance with what had been done before, and in setting about improvement in a thoroughly scientific way."

Composite Photography of Handwriting.—Dr. Persifer Frazer has published a paper on "Composite Photography applied to Handwriting." The principle of the application is the same as that proposed by Mr. Galton for the production of composite portraits, to be typical of a family, a race, or a class of persons. With relation to the practical value of the application contemplated in Mr. Frazer's paper, the author says that, in examining with care a composite signature, "it at once arrests the attention that the variations are not equally distributed over the entire body of the letter, but that there are regions of each letter where variations of a particular kind are noticeable, and other regions where there are few or none. The more the manuscripts of an individual are compared the more forcibly does this fact appear, until finally one is tempted to conclude that after a handwriting is once formed it can not *naturally* exhibit deviations except within a defined variation and in certain limited areas adjacent to the separate letters. It is thus as great an assistance to an observer to study the variations as to study the ideal signature. Indeed, the variations are all-important in the matter of identification, and if there were no variations the method would be inapplicable, because an exact copy might be made by tracing." The principle was applied by Mr. Frazer in a recent case in a Philadelphia court, and he thinks, from the experience thus far gained, that "it will (at least in many cases) more surely lead to the truth than will the mere opinions of the most skillful expert."

Sesostris.—On the first day of June last, M. Maspero, in the presence of the Khedive and a number of Egyptian and European notables, unwrapped the bandages of the mummy of Rameses II—the Sesostris of the Greeks, and the Pharaoh of Moses and the Hebrew oppression—which was found about two years ago at Dayr-el-Bahari, near Thebes. The mummy was identified by the inscriptions on the lid of the sarcophagus and on the outer winding-sheet. The profile of the goddess Nut, which was painted on a linen sheet covering the front of the mummy, was "unmistakably designed after the pure and delicate profile of Seti I," the father and predecessor of Rameses. In a quarter of an hour after the unrolling was begun, the face of the monarch was revealed, as it had been laid away 3,300 years ago. "The head is long, and small in proportion to the body. The top of the skull is quite bare. On the temples there are a few sparse hairs, but at the poll the hair is quite thick, forming smooth, straight locks about five centimetres in length. White at the time of death, they have been dyed a light yellow by the spices used in embalmment. The forehead is low and narrow; the brow-ridge prominent; the eyebrows are thick and white; the eyes are small and close together; the nose is long, thin, hooked like the noses of the Bourbons, and slightly crushed at the tip by the pressure of the bandages. The temples are sunken; the cheek-bones very prominent; the ears round, standing far out from the head, and pierced, like those of a woman, for the wearing of earrings. The jawbone is massive and strong; the chin very prominent; the mouth small but thick-lipped, and full of some kind of black paste. This paste, being partly cut away with the scissors, disclosed some much worn and very brittle teeth, which, moreover, are white and well preserved. The mustache and beard are thin. They seem to have been kept shaved during life, but were probably allowed to grow during the king's last illness; or they may have grown after death. The hairs are white, like those of the head and eyebrows, but are harsh and bristly, and from two to three millimetres in length. The skin is of earthy brown splotched with black. Finally, it may be said that the face of the mummy gives a fair idea of the face of the living king. The expression is unintellectual, perhaps slightly animal; but, even under the somewhat grotesque disguise of mummification, there is plainly to be seen an air of sovereign majesty, of resolve, and of pride. The rest of the body is as well preserved as the head; but in consequence of the reduction of the tissues its aspect is less life-like. . . . The corpse is that of an old man, but of a vigorous and robust old man. We know, indeed, that Rameses II reigned for sixty-seven years, and that he must have been nearly one hundred years old when he died." Another mummy, which had been laid in the sarcophagus of Queen Nofretari, queen of Ahmes I of the eighteenth dynasty, proved, when unbandaged, to be the mummy of Rameses III, another great king, of the twentieth dynasty. It was less well preserved than the mummy of Rameses II. The physiognomy is more delicate and more intelligent; but the height of the body is less, the shoulders are less wide, and the strength of the man was inferior. The two mummies, replaced in the glass cases, will be exhibited with their faces uncovered in the museum at Boulak.

Maternal Families.—Sir George Campbell, president, began his address to the Anthropological Section of the British Association with some observations on the races of India. He spoke particularly of the Khassyahs, a very peculiar people of the hill regions, with highly developed constitutional and elective forms of government, who were also specially interesting as exhibiting an excellent specimen of the matriarchal or matriherital system fully carried out under recognized and well-defined law among a civilized people. The result of his observation of them had been to separate in his mind the two systems of matriheritage and polyandry, and to suggest that polyandry was really only a local accident, the result of scarcity of women. Among the Khassyahs there was no polyandry, so far as he had been able to learn, though there was great facility for divorce; and heritage through the female became quite intelligible when he saw that the women did not leave the maternal home and family and join any other family, as do the Aryans. They are the stock-in-trade of the family, the queen-bees, as it were; they take to themselves husbands—only one at a time—and, if he is divorced, they may take another; but the husband is a mere outsider belonging to another family. The property of the woman goes in the woman's family, the property of the man in his own maternal family. It should be added, however, that in these maternal families, though the heritage comes through the female, the males rule. The extension of our accurate information respecting the diverse peoples of India might throw a flood of light on the social history of the human race. The speaker then proceeded to what he announced as the main object of his address—to recommend the systematic and scientific cultivation of man, which he might call homi-culture, with a view both to physical and mental qualities. It seems very sad, indeed, he said, that when so much has been done to improve and develop dogs, cattle, oysters, and cabbages, nothing whatever has been done for man, and he is left very much where he was when we have the first authentic records of him. Knowledge, education, arts, he has no doubt acquired; but there seems to be no reason to suppose that the individual man is physically or mentally a superior creature to what he was five thousand years ago. We are not sure that under very modern influences he may not retrograde. In regard to animals and plants we have very largely mastered the principles of heredity and culture, and the modes by which good qualities may be maximized and bad ones minimized. Why should not man be similarly improved? Surely, if we only have the requisite knowledge, and, taking a practical view of life, could regulate our domestic arrangements with some degree of reason, rather than by habit, prejudice, and the foolish ideas cultivated by foolish novelists, this might be done. Probably we have enough physiological knowledge to effect a vast improvement in the pairing of individuals, if we could only apply that knowledge to make fitting marriages, instead of giving way to foolish ideas about love and the tastes of young people, whom we can hardly trust to choose their own bonnets.

The Place of Geography in School-Studies.—The burden of General Sir F. J. Goldsmid's presidential address before the Geographical Section of the British Association was, that the place which geography holds among school-studies is not that which it ought to hold if its uses were understood and appreciated. As a matter of state and public-school education, the science of geography should be elevated, not degraded. It should be placed on a par with classics, mathematics, and history, with each and all of which it has affinity. A knowledge of geography is not one of those accomplishments which will come, as it were, of themselves, or are the outcome of lightly sown seeds in the home; it will not come, like handwriting, with incidental practice, nor is it to be gained by mere traveling. After a running review of the principal geographical work of the world during the year, the speaker mentioned the east and west coasts of Africa as two regions in which geographical activity had been evinced in a remarkable degree. "It is really astonishing," he said, "to trace the changes in a map of Africa during the last quarter of a century. Large spaces that were quite blank have been filled up with conspicuous delineations of mountains, fine lines representing rivers, crossed by or connected with finer lines of affluents or feeders, with names, circles, and dots for towns or villages. Yet, as I now contemplate that map in its latest form, it seems to me that hundreds of spots visited have yet to be indicated, and that the coast lines of the Indian Ocean on the one side and the Atlantic on the other are teeming with life imported, as it were, from Europe." An adequate knowledge of geography combined with history ought to have contributed to prevent the English Government consenting to the treaty it has made, though it is still unratified, with Portugal, respecting the lower Congo. While full information respecting the history and geography of such important countries as Afghanistan, Beloochistan, and Persia, is available in books, it is nowhere to be found in the comprehensive form that would necessarily be adopted were geography honored with professorial chairs; but, in the absence of the appropriate manual, search must be made in encyclopædias, gazetteers, and volumes of history and travel.

NOTES.

The question of the origin of the red sunsets, which still continue to appear at times, is yet a subject of discussion. The theory of their being due to volcanic dust in the air is still most in favor, but their persistency is by some regarded as a cause of objection to it. Professor Newcomb suggests in "Nature" that, in order to reach a decisive conclusion on the matter, we must have observations made in regions where the upper atmosphere is exceptionally free from vapors and other attenuated matter, and where, consequently, the advent of such matter could be detected when it could not be determined at other places. He names the Cape of Good Hope as such a region, and hopes that observers there will give special attention to the investigation.

Professor F. W. Putnam gave, in the American Association, a *résumé* of results from his explorations of burial-places, mounds, and earthworks, during the past twenty years, in various parts of the United States. They go to show that successive peoples have inhabited the several regions of the country, and that the mounds were made by different people at different times, as evidenced by their structure and contents.

Professor Boyd Dawkins said, in a British Association paper on the exploration of Gop Cairn, commonly known as Queen Boadicea's tomb, and of the cave at St. Asaph, that the human remains found in the cave threw great light on the ethnology of the district in the bronze age, and proved that in the Neolithic age the population of that part of Wales was of the Iberian type. All the skulls were of this type save one, and that possessed all the characteristics usually found in a round-headed Celt of the bronze age. These appeared to indicate that fusion of the two races which has been going on ever since, and by which the Iberian type is at the present time being slowly obliterated.

Joseph Jastrow communicated to the American Association an account of some experiments with ants, from which it results that, having regard to the difference in size, these little insects walk from seven to fourteen times as rapidly as man. Other experiments indicated a sensitiveness to odors. When brushes were dipped in various substances, the ants invariably took notice of those which had been dipped in lavender, and mostly noticed those which had been dipped in cloves or mint, but were indifferent to brushes which had been dipped in distilled water. Lavender appears to be extremely disagreeable, and even deadly, to them.

Pertinently to a controversy between German and Scandinavian archæologists as to priority in the classification of the prehistoric ages—stone, bronze, and iron—Professor Virchow contends that two Germans, Lish and Danneil, discovered the three ages simultaneously with the Dane Thomsen. In support of his position, he quotes a memoir by Lish, which was published in 1837, but was in large part printed in 1836, before Thomsen's work appeared, and when it was wholly unknown to him, expounding a similar theory. In 1835, Lish had actually arranged prehistoric objects in the museum in Mecklenburg, according to the three ages. Danneil's share in the discovery does not appear so pronounced.

It is usually believed that bats hibernate at home, in a dormant condition in caves, hollow trees, and other places of retreat. But according to Dr. C. H. Merriman's observations, as he related them in the American Association, the evidence is complete that the hoary bat and the silver-haired bat emigrate. The hoary bat belongs to the Canadian fauna, but in fall and winter occurs at places far to the southward of its breeding-range. The silver-haired bat occurs regularly in spring and fall at a lonely rock about twenty miles off the coast of Maine. No bats breed at this place, and the nearest island is fourteen miles distant.

A remarkable illustration of the power of lightning has been observed at Löiten, Norway, where a fir-tree eighty feet in height was struck, with such effect, that it was cut in two, and the upper part, which was about sixty feet in length, was thrown to a distance of several yards. The surface of the detached part is as smooth as if it had been cut with a saw, while the stump is jagged, charred, and split to the root. The ground around the tree is furrowed in all directions.

M. Walther has made some observations in the Mediterranean Sea of the manner in which chalk is formed by sea-weeds. He particularly studied the *Lithotamnia* of the Bay of Naples, which grow at depths of from one hundred to three hundred feet, a class of algæ remarkably poor in organic matter, but rich in mineral constituents, among which carbonate of lime is preponderant. They grow to be about as large as the hand, and then die without suffering change of form by decomposition. Living plants attach themselves to dead ones, and thus extensive deposits are formed. Beds of pure, uncrystallized chalk remain after the gradual disappearance of the organic matter, the vacancies left by which are gradually filled with calcareous substance. Beds of chalk thus formed may, under some conditions, attain great thickness.

M. Pasteur recently reported concerning 1,656 cases which he had treated of persons bitten by rabid animals. Of 1,009 French cases, 3 had died; of 182 Russians, 11, 8 of whom had been bitten by wolves, not by dogs; of 20 Roumanians, 1; of 445 from other countries, including 18 from America, none. The total number of deaths was, therefore, fifteen, or less than one in a hundred.

The committee of the British Association on Antarctic research has reported that, in view of the great increase in facilities for prosecuting work of that kind consequent upon the development of steam navigation, it desires to secure a full discussion of plans for the purpose of giving more definiteness to the objects sought to be obtained, and to the best means of obtaining them.

Sea-trout have been artificially spawned with great success at the South Kensington aquarium, even from fish which had been kept in captivity for three years and had never visited the sea. The different species of the *Salmonidæ* living in the tank are found to pair quite readily with one another. Fish in captivity yield their ova much later than they do when in a wild state; but, of every thirty subjected to artificial existence, only one is, on the average, barren.

A committee has been formed in Paris for the organization of a floating exhibition for the purpose of bringing the products of French industries within the view of the people of other countries. The Sarthe, a vessel of 3,900 tons, has been furnished to the enterprise by the Minister of Marine. The exhibition will fill about 1,600 cubic metres of glass cases and counters; and 400 square metres will be given to machinery. The first voyage of the exhibition will be to the coasts of Central and South America.

It was reported recently, in the Royal Society of Tasmania, that a Mr. Vimpany had captured a black snake four feet three inches long, in which one hundred and nine young ones were found. The greatest number said to have been before taken from a single snake was seventy.

M. Lewin has reported to the Berlin Medical Society his observation of an affection that seems to be peculiar to workers in silver. It appears in the form of round or oval bluish spots on the skin, which in extreme cases may be as large as a nickel five-cent piece, generally on the back of the left hand. Workmen in metals who do not use silver are free from it. The manner in which the spots are produced is not clear, for experiments with the direct application of silver in various forms have failed to generate them. The silver probably falls upon some scratch—for the spots are usually developed where there has been a lesion—in a solution, and afterward undergoes some chemical change by the action of the bodily fluids which induces the peculiar color.

Mr. W. H. Preece described, in the British Association, how he had extracted a piece of needle from his daughter's hand by the aid of a suspended magnetized needle. The needle was strongly deflected, and invariably, when the hand was moved about, pointed to one position, which was marked with a spot of ink. The needle was afterward extracted by cutting at this spot.

Pertinently to the question whether man in the palæolithic age was acquainted with the potter's art, M. Martel reports that he found last year in the cave of Nabrigas, in immediate contact with the remains of specimens of the cave-bear, nine fragments of human skulls, and a piece of rough pottery, not turned in a lathe. In connection with this discovery he adduces the fact that, fifty years ago, M. Joly found in this same cave a fragment of a large vessel in contact with the skull of a fossil bear. There is no trace of any disturbance, no other neolithic objects are found, and the skull is in its natural position; therefore he is persuaded that the question should be answered in the affirmative.

Tommasi-Crudelli and Klebs published the account of the discovery of the schizomycete (*bacillus malariæ*) as the causal agent of malarious fevers, in 1879. Marchiafava and Celli have announced, as the result of their researches on an individual affected with malaria, that within the red-blood globules are constantly found plasmatic bodies endowed with lively amœboid movements, in which the hæmoglobine is transformed into melanine; and in a further memoir they suggest that these plasmatic bodies may be the living organisms that produce malaria. Thus they confirm in substance Tommasi-Crudelli's opinion that a living organism is the cause of malaria, but they regard its form as differing from a schizomycete.

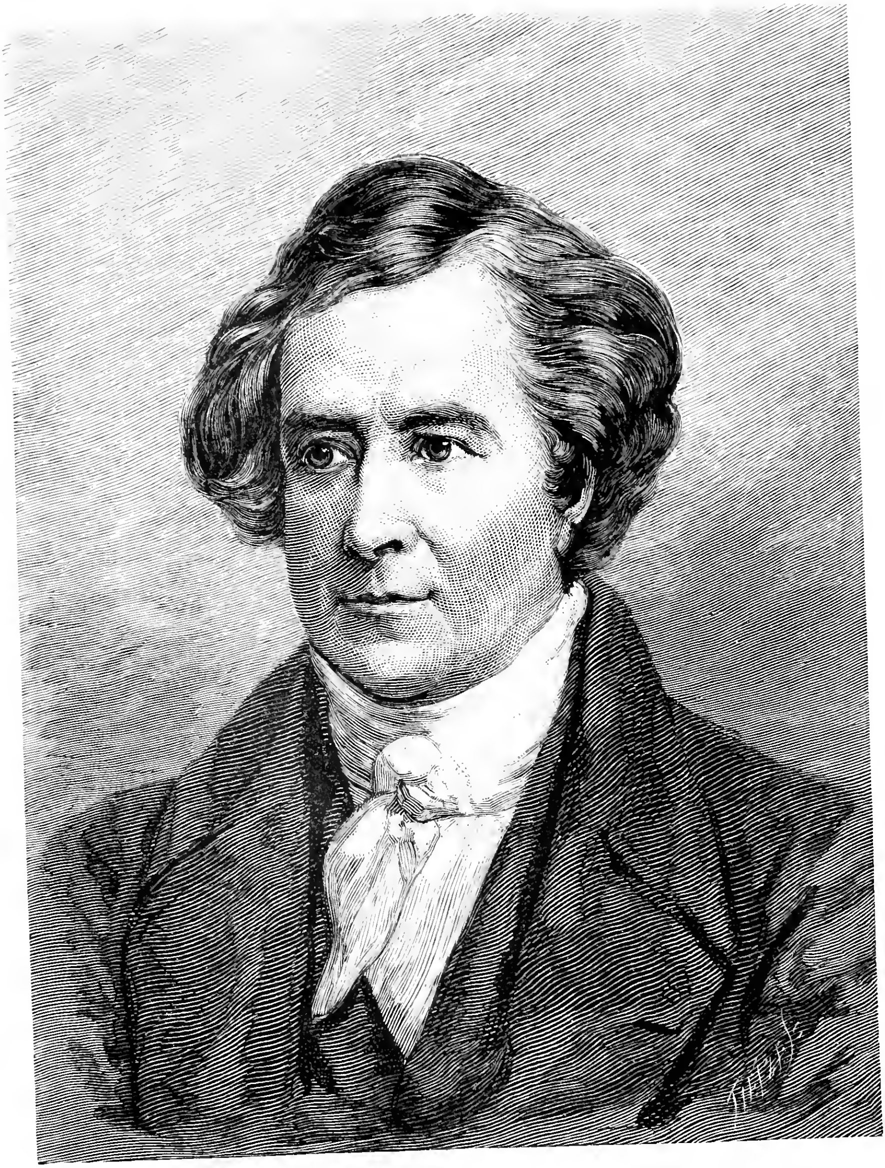
Professor Windle has announced to the British Association, as conclusions from his researches on the subject, that man's original dentition included six incisors in either jaw; that two from each jaw have gradually disappeared; that this loss is due to the contraction of the anterior part of the palate; that this process of contraction will probably go on and result in the loss of two further incisors; and that the conical shape of many of the supernumerary teeth indicates a reversion to the primitive type of tooth.

The operation of compulsory vaccination was suspended in Zürich, Switzerland, in obedience to popular clamor, in 1883. The deaths from small-pox per 1,000 total deaths for the two previous years and that year had been, in 1881, 7; in 1882, 0; in 1883, 8. They rose, after compulsion had ceased to be used, in 1884, to 11·15; in 1885, to 52, and in the first eight months of 1886, to 85, per 1,000.

Mr. James W. Wells relates that while exploring the stream connections between the head-waters of the Brazilian Rios Tocantins and San Francisco, in 1875, the natives, unaccustomed to the sight of white men, attached a mystery to the presence and personality of one who was neither a trader, planter, priest, nor soldier. They finally decided that he was anti-Christ entering the country with the object of making slaves of the people and heathenizing them; and they were afterward discovered most fervently offering up prayers for deliverance from the machinations of the evil-one.

A very severe earthquake occurred in Greece, the Ionian Islands, and other lands of the Mediterranean Sea, on the 29th of August. In the southwestern Peloponnesus, four considerable towns and a large number of prosperous villages, with about sixty thousand houses, were destroyed, and hundreds of persons were killed. An eruption of Vesuvius was reported at about the same time. The close approach to coincidence in time—making allowance for the distance—of this earthquake with that at Charleston is noticeable; but it is not supposed that a coincidence exists in any other respect.

Artesian wells are of great antiquity in China. Abbé Huc describes the method in which they were bored. It is by tubulation, and drilling with a rammer regulated by a rattan cord—a rude suggestion of the more perfect apparatus which is now used among us.



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SCIENCE AND THEOLOGY.

By JOHN BURROUGHS.

ONE of the latest phases of the religious thought of the times seems to be a desire to get rid of, or to explain away, the supernatural —at least to reclaim and domesticate it and convince mankind that it is not the irresponsible outlaw we have so long been led to suppose —a desire nearly as marked in the theology as in the science of the day. Thus, the Bishop of Exeter (Dr. Temple), in his Bampton Lectures of 1884, on the "Relations between Religion and Science," upholds the belief in miracles, without calling to his aid the belief in the supernatural as the word is commonly used. A miracle, he urges, *may* be only some phase of the natural not yet understood; the turning of water into wine by word of command, or the miracle of the loaves and the fishes, may have been accomplished by the exercise of some power over Nature which is perfectly scientific, but of which man as yet has imperfect control.

And the Duke of Argyll, in his "Reign of Law," cautions us against assigning an event or a phenomenon to the agency of the supernatural until we are quite sure we understand the limits of the natural—the natural may reach far enough to include all that we have commonly called the supernatural. The latest considerable attempt in this direction is furnished by the work of Professor Henry Drummond on "Natural Law in the Spiritual World," a work which undertakes to demonstrate the naturalness of the supernatural, or the oneness of religion and biology.

Butler, in his "Analogy," says that there is no "absurdity in supposing that there may be beings in the universe whose capacity and knowledge and views may be so extensive as that the whole Christian dispensation may to them appear natural; that is, analogous or conformable to God's dealings with other parts of his creation; as natural as the visible known course of things appears to us."

Such a being seems actually to have appeared in the person of this Scotch professor. The "whole Christian dispensation" is to him little more than a question of experimental science; the conversion of Paul is as natural and explicable a process to him as the hatching of an egg, or the sprouting of a kernel of corn. "Religion," he says, "is no disheveled mass of aspiration, prayer, and faith. There is no more mystery in religion as to its process than in biology." The question of a future life is only a biological problem to him. He gives physiological tests by which a man may surely know whether or not he is a true Christian. The characteristics of life in the organic world, he argues, are four, namely, assimilation, waste, reproduction, and spontaneous action; the characteristics in the Christian world are the same, *must* be the same, else the law of continuity, upon which he has built, fails. But he wisely refrains from applying these tests in detail to the spiritual life of the Christian. He says: "The experiment would be a delicate one. It might not be open to every one to attempt it. This is a scientific question; and the experiment would have to be conducted under proper conditions and by competent persons."

There is little mystery in the universe to a mind like Drummond's; or, if there is any mystery, he knows exactly what and where it is; he has cornered and labeled it, so that it shall give him no further trouble.

We hardly need the confession which he makes in his preface, that his science and his religion have got so thoroughly mixed that either can be expressed in the terms of the other. For a time, he says (while he was teaching the two, one on week-days, the other on Sundays), he succeeded in keeping them shut off from one another in two separate "compartments" of his mind. "But gradually the wall of partition showed symptoms of giving way. The two fountains of knowledge also slowly began to overflow, and finally their waters met and mingled. The great change was in the compartment which held the religion. It was not that the well there was dried; still less that the fermenting waters were washed away by the flood of science. The actual contents remained the same. But the crystals of former doctrines were dissolved; and, as they precipitated themselves over more indefinite forms, I observed that the Crystalline System was changed. New channels for outward expression opened, and some of the old closed up; and I found the truth running out to my audience on Sundays by the week-day outlets."

It is but fair to say that this extract does not show our professor's style at its best, but rather at its worst. At its worst it is grossly materialistic, and goes in the leading-strings of a cheap and overwrought analogy. At its best it is often singularly clear and forcible, even flexible and buoyant, but it always wants delicacy and spirituality, and appeals to the scientific rather than to the religious sense. But a more confused mixture of science and theology probably the whole range of printed books does not afford. The positions and conclusions of the latter are constantly uttered as if they were the demonstrations of the former. And this is the obnoxious feature of the book. With Professor Drummond's theology, as such, I have nothing to do, having long ago made my peace with Calvinism. It is only because he utters his theology in the name of science, or as the result of a scientific demonstration, that I am occupied with him here.

When it is declared by a college Professor of Natural Science, as it virtually is in this book, that in the laws and processes of the physical universe that which is science at one end is Scotch Presbyterianism at the other, the proposition arrests attention by its novelty at least.

"The spiritual world as it stands," he declares, "is full of perplexity. One can escape doubt only by escaping thought. . . . The old ground of faith authority is given up; the new [ground] science has not taken its place." It is his purpose to give to faith this new ground of science. Up to this time, he says, the spiritual world has been looked upon as outside of natural law. Evolution and revelation have been at swords' points; he has not merely made peace between them, but he clearly believes himself to have enlisted the forces of the former under the banner of the latter. Science, he says, can hear nothing of a "Great Exception." The present decadence of religion is owing to the fact that it has been too long treated as the great exception—cut off by an insurmountable barrier from the natural order of things. It is now found by this Christian philosopher to be as completely under the dominion of natural law as any branch of physical science. What Jussieu and De Candolle did for botany in substituting the natural system for the artificial, what Lyell did for geology in getting rid of "catastrophism," what Newton did for astronomy by his law of gravitation, our Glasgow professor flatters himself (rather covertly, to be sure) he has done, or showed the way to do, for theology. He has introduced law and order where before were chaos and "perplexity."

All this sounds as promising to the man of science as it must sound bewildering and discouraging to the theologian—because, has not theology always maintained that revealed religion was superior to reason, and that the natural man, with his profane sciences, was at enmity with God?

Sir Thomas Browne speaks as a theologian when he says that reason is a rebel unto faith, and that "many things are true in divinity which are neither inducible by reason nor confirmable by sense"; but he spoke as a man of science when he said: "I can cure vices by physic when they remain incurable by divinity; and they shall obey my pills when they contemn their precepts." Indeed, science and divinity occupy essentially different points of view, in many respects antagonistic points of view.

Science, in the broadest sense, is simply that which may be verified; but how much of that which theology accepts and goes upon is verifiable by human reason or experience? The kind of evidence which theology accepts, or has accepted in the past, is too much like that which led the old astrologer Nostradamus to predict the end of the world in 1886, because in this year Good-Friday falls upon St. George's day, and Easter upon St. Mark's day, the very latest date upon which Easter can happen.

Theology, for the most part, adopts the personal point of view—the point of view of our personal wants, fears, hopes, weaknesses, and shapes the universe with man as the center. It has no trouble to believe in miracles, because miracles show the triumph of the personal element over impersonal law. Its strongest hold upon the mind of the race was in the pre-scientific age. It is the daughter of mythology, and has made the relation of the unseen powers to man quite as intimate and personal. It looks upon this little corner of the universe as the special theatre of the celestial powers—powers to whom it has given the form and attributes of men, and to whom it ascribes curious plans and devices. Its point of view is more helpful and sustaining to the mass of mankind than that of science ever can be, because the mass of mankind are children, and are ruled by their affections and their emotions. Science chills and repels them, because it substitutes a world of force and law for a world of humanistic divinities.

Of all the great historical religions of the world, theology sees but one to be true and of divine origin; all the rest were of human invention, and for the most part mere masses of falsehood and superstition. Science recognizes the religious instinct in man as a permanent part of his nature, and looks upon the great systems of religion—Christianity, Judaism, Buddhism, Mohammedanism, the polytheism of Greece, Rome, and Egypt, etc.—as its legitimate outgrowth and flowering, just as much as the different floras and faunas of the earth are the expression of one principle of organic life. All these religions may be treated as false, or all of them treated as true; what we can not say, speaking for science, is, that one is true and all the others are false. To it they are all false with reference to their machinery, but all true with reference to the need to which they administer. They are like the constellations of the astronomical maps, wherein the only things that are true and real are the stars; all the rest—Ursa Major, Cassiopeia, Orion, etc.—are the invention of the astronomers. The eternal truths of man's religious nature have lent themselves to many figures of polytheism as well as of Christianity; these figures pass away or become discredited, but the truths themselves—the recognition of a Power greater and wiser than ourselves, to the law of which it is necessary that our conduct in some measure conform—never pass away. Was not Egypt saved by her religion, and Greece by hers, as much as England is by hers?

Indeed, the question which it is not safe to ask of any religion is just the one we are prone to ask first, namely, Is it true? A much safer question is, Is it saving? That is, does it hold men up to a higher standard of life and duty than they were otherwise capable of? Does it cheer and sustain them in their journey through this world? Could the religion of Greece have faced the question, Is it true? And yet the German historian of Greece, Dr. Curtius, says that the religion of Apollo "was nowhere introduced without taking hold of and transforming the whole life of the people. It liberated men from dark and groveling worship of Nature; it converted the worship of a god into the duty of moral elevation; it founded expiations for those oppressed with guilt, and for those astray, without guidance, sacred oracles." Can historical Christianity any better face the question, Is it true? Did all these events fall out as set down in the New Testament? Are they set in their true light? And yet who besides Professor Clifford dare say that Christianity has not been a tremendous power in elevating and civilizing the European nations?

Science affirms that every child born of woman since the world began belonged to the human species, and had an earthly father; theology affirms that this is true of every child but one: one child, born in Judea over eighteen hundred years ago, was an exception, was indeed very God himself. Theology makes a similar claim with regard to the Bible. It affirms that every book in the world was written by a human being, and is therefore more or less fallible and imperfect, with the exception of one—that one is the Bible. This is the great exception: the Bible is not the work of man, but is the word of God himself uttered through man, and is therefore infallible. Science simply sees in the Bible one of the sacred books of the nations—undoubtedly the greatest of them all—but still a book or a collection of books embodying the history, the ideas, the religious wants and yearnings of a very peculiar people—a people without a vestige of science, but with the tie of race and the aspiration after God stronger than in any other people—a people still wandering in the wilderness, and rejected by the nations to whom they gave Christianity. Science knows God, too, as law, or as the force and vitality which pervade and uphold all things; it knows Christ as a great teacher and prophet, and as the savior of men. How? By virtue of the contract made in the Council of the Trinity as set forth in the creed of Calvinism? No; but by his unique and tremendous announcement of the law of love, and the daily illustration of it in his life. Salvation by Christ is salvation by self-renunciation, and by gentleness, mercy, charity, purity, and by all the divine qualities he illustrated. He saves us when we are like him, as tender, as charitable, as unworldly, as devoted to principle, as self-sacrificing. His life and death do inspire in mankind these things; fill them with this noble ideal. He was a soul impressed, as perhaps no other soul ever had been, with the oneness of man with God, and that the kingdom of heaven is not a *place*, but a state of mind. Hence, coming to Christ is coming to our truer, better selves, and conforming our lives to the highest ideal. Was not Paul a savior of mankind also? Without Paul it is probable that Christianity would have cut but an insignificant figure in this world. He was its thunderbolt; his words still tingle in our ears.

I by no means say that this is the only view that can be taken of Christ as the Saviour of mankind; I say it is the only view science or reason can take—the only view which is in harmony with the rest of our knowledge of the world.

What can science, or, if you please, the human reason, in its quest of exact knowledge, make of the cardinal dogmas of the Christian Church—the plan of salvation, justification, the Trinity, or "saving grace," etc.? Simply nothing. These things were to the Jews a stumbling-block and to the Greeks foolishness, and to the man of science they are like an utterance in an unknown tongue. He has no means of verifying them; they lie in a region entirely beyond his ken.

Witness the efforts of the Andover professors, in their latest manifesto, "Progressive Orthodoxy," to give a basis of reason to the dogma of vicarious atonement. The result is mere verbal jugglery. To say that Christ, laying down his life, makes you or me, or any man, *capable* of repenting in a way or in a degree we were not capable of before, or that a man's capacity in any direction can be increased without effort on his part, and by an event of which he may never have heard, are assertions not credible, because they break completely with the whole system of natural knowledge.

In short, the truth of this whole controversy between science and theology seems to me to be this: If we take science as our sole guide, if we accept and hold fast that alone which is verifiable, the old theology, with all its miraculous machinery, must go. But if there is a higher principle by which we are to be guided in religious matters, if there is an eye of faith which is superior to the eye of reason—a proposition which I for one neither affirm nor deny—then the whole aspect of the question is changed, and it is science and not theology that is blocking the way.

But the attitude of Professor Drummond is, that there is nothing true in divinity that is not true in science, or at least in harmony with science, and the main purpose of his book is to demonstrate this fact.

The proof here offered is nothing more than the old argument from analogy, the analogy being drawn from the principles of biology instead of from the general course of nature, as with Butler. It is the assumption that these biological processes or laws are identical in the spiritual and physical spheres that furnishes the starting-point of the book. "The position we have been led to take up is not that the spiritual laws are analogous to the natural laws, but that they *are the same laws*. It is not a question of analogy, but of *identity*." Still, the identity is not proved ; the analogy alone is apparent. In the physical sphere science often recognizes the same laws appearing under widely different conditions. For instance, the process by which animal life is kept up is no doubt a real combustion, identical in kind with that which takes place in the consumption of fuel by fire. Lavoisier and Laplace long ago taught us that there are not two chemistries —one for dead bodies and another for living—on the contrary, one system of laws, chemical, mechanical, physical, everywhere prevail. Again, there are few exact terms that we apply to objective nature that we do not apply upon the principle of analogy to subjective nature, as high and low, interior and exterior, flexible and inflexible, hard and soft, attraction and repulsion, etc. Indeed, our whole language, in its higher ranges, is a perpetual application of the principle of analogy. But to aver that physical laws are operative in the spiritual world, even in the spiritual world of Calvinistic theology, is quite another matter, and is to take a leap where science can not follow. Hard and inflexible as the Calvinistic heaven is, it is doubtful if the law of gravitation reaches so far, though our professor does not flinch at all at this assumption (see page 42).

"Nature," he again says, "is not a mere image or emblem of the spiritual. It is a working model of the spiritual. In the spiritual world the same wheels revolve, but without the iron" (page 27). It is something to be assured that the iron is left out ; the wheels are enough. Though why not the iron also, since we are still within reach of the same physical laws?

There is nothing more taking than the argument from analogy, but probably no species of reasoning opens so wide a door for the admission of error. It is often a powerful instrument in leading and persuading the mind, because it awakens the fancy or stirs the imagination ; but its real scientific value, or its value as an instrument for the discovery of truth, is very little, if it has any at all. The fact of the metamorphosis of the caterpillar after an apparent death into a winged insect may lend plausibility to the doctrine of the soul's immortality, but can it be said to furnish one iota of proof? Indeed, to a mind bent upon anything like scientific certitude in such matters, Butler's whole argument for a future life can hardly be of a feather's weight, because he seeks to prove by reason or comparison that which experience alone can settle.

Paul reasoned from analogy when he sought to prove the doctrine of the resurrection of the body. He appealed to a perfectly natural and familiar phenomenon, namely, the decay and transformation of a kernel of wheat in the ground before it gives birth to the stalk and the new grain. But see how the doctrine which he maintained so eloquently has faded, or is fading, from the mind of even orthodox Christendom! Analogy is valuable as rhetoric, but in the serious pursuit of truth it can be of little service to us. When employed for its argumentative force, it proceeds upon the theory that if two things be compared, a matter in question with a matter about which there can be no question, and the former be found to agree in its *rationale* with the latter, the presumption is that it is true as the latter is true. But this mode of reasoning is of no value in religious matters, because here we shape the unknown from our knowledge of the known, and the agreement between the two is already assured. The world of myth and fable bears a resemblance more or less striking to the real world, but does that afford any ground for our accepting the myths and fables as actual facts and occurrences?

Suppose the doctrine of Christian conversion, as expounded by Paul, is found to agree with certain well-known and universal facts of human life, does that prove the doctrine to be true? Or does it prove that Paul predicated his doctrine upon the knowledge of these facts? Milton's rebellious angels in their warfare against the hosts of heaven may not violate one rule of good English military tactics, but that fact would hardly be counted sufficient evidence for our accepting the rebellion as an actual historical event. Indeed, when our theological friends ask us to accept their dogmas on the ground that they are no more unreasonble or inexplicable than many things which we do believe, and which all the world believes, they usually make the mistake of expecting us to award the same weight to the argument from analogy that we do to proof from experience.

That a thing is mysterious or inexplicable affords no grounds for our refusing to credit it. We can not explain the simplest facts of our lives; we are embosomed in mystery. We do not know how our food nourishes us, or how our sleep refreshes us, yet we know that they *do* nourish and refresh us, and that is enough. What a mystery that an ugly worm should become a gorgeous butterfly, or that from a little insensate egg should come a bird with all its powers of flight and song! How wonderful and inexplicable are the commonest facts and occurrences about us! Yet we know that things do turn out thus and thus and not otherwise, and we know it not from reason but by experience. We know that a man may survive the amputation of his arms and legs, but do we know that he can survive the amputation of his head? A tree or a cabbage survives the amputation of its head; the stump will sprout again, why not a man? It is not a matter of reason, I say again, but of experience. When the doctrine of the Trinity can be confirmed by the same test, then it will be just as easy to believe it true as it is that water flows or is solid according to the temperature. The difficulty with the theologians is that, while they so often appeal to our experience in establishing their premises, they at once go beyond our experience in drawing their conclusions.

The analogy upon which Professor Drummond builds so confidently will be found comforting and reassuring to those who are already of his creed, but to the disinterested inquirer, determined to hold fast alone to that which is verifiable, it is little more than a clever rhetorical flourish.

His argument in a nut-shell is this : There are three kingdoms—the inorganic, the organic, and the spiritual—each atop of the other, and carrying the same law into higher regions. There may be other kingdoms, he says, higher in the scale than the spiritual, or the kingdom of God, of which we as yet know nothing. But of these three we do know, and with these we have to deal. The law of evolution works in each one of these kingdoms up to a certain point, when there is a break and miracle, or an outside power steps in. There is no passage from the inorganic to the organic without a miracle, and no passage from the natural to the spiritual without a miracle. Evolution worked in the nebulous matter till the worlds were formed and ready for life : to introduce that life, God did directly step in by a creative act. This done, evolution went to work again and carried forward the process until the series of sentient beings was crowned by man. Then evolution came to the end of its tether again ; to reach the spiritual kingdom the intervention of a miraculous power was again required. A man can no more become a Christian by his own will or act than the inorganic can become the organic. *He can not*—the thing is simply impossible ; and our author brings Scriptural texts to support his position. This leads him into good old-fashioned Calvinism, and good old-fashioned Clavinism he advocates and seeks to clinch with his scientific hammer. Indeed, his aim is to lend the great authority of science to this all but outgrown creed, and he evidently flatters himself that he has established the truth of it beyond all question. The reader soon perceives that the spiritual world of which he is all the while talking is not the spiritual world of the rest of mankind—the world of spirit as opposed to that of matter, the world of mind and consciousness of which all men are more or less partakers by virtue of their humanity—but the spiritual world as interpreted by a certain Christian sect, a very limited and a very recent affair, of which the mass of mankind have never even heard, and in which the sages and prophets of antiquity have no part nor lot. The curious and astonishing thing about the argument is, not the bringing forward and the insisting upon this kind of a spiritual world, for theology has long ago made us familiar with this claim, but the bringing of it forward in the name of science and substituting it for the spiritual world which science really recognizes. In following his argument one constantly feels the ground disappearing beneath him, or before him. His spiritual kingdom does not belong to the same order of fact as the other two : it is not a link, or a step in a natural series, but a domain by itself entirely apart from human reason or experience. In clapping it on top of the physical universe in the way it has been done here, and claiming that its position there is logical or scientific, is to do violence to common sense. Its position there is forced and arbitrary.

In the order of Nature what goes atop of the animal world is the world of consciousness, the world of mind and spirit which attains to its full flowering in man. This is no limited or accidental world, thrust upon the few, and denied to the many, but a world which belongs to the natural order of the universe. The passage to it from the animal is so gradual that science can not say where the one ends and the other begins. In the same manner the animal fades into the vegetable, and the vegetable into the mineral. There are no breaks, there are no gulfs fixed. "There exists no insurmountable chasm between organic and inorganic nature," says Hankel, speaking for the most thorough science of his times. Huxley and Tyndall and the leading French scientists have reached the same conclusion. The organic and the inorganic are composed of the same elements; their differences arise solely from the different chemical combination of these elements, a combination so peculiar and complex that Science has not yet been able to reproduce it in her laboratory. But the fact that spontaneous generation has not yet taken place under the highly artificial conditions imposed by experimental chemistry proves what? Proves only that it has not yet taken place, that science with its limited means and brief space of time has not yet accomplished that which must have occurred under vastly different conditions in the abysm of geological time, and in the depths of the primordial seas. Science starts with matter and with force; back of these it does not go; more than these it does not require. To account for them, or to seek to account for them, is unscientific, for the simple reason that no such accounting can be verified. Out of the potencies of matter itself science traces the evolution of the whole order of visible things. Theology may step in and assume to know all that Science leaves unsaid, but, in doing so, let it not assume to speak with the consent and the authority of its great rival.

In the light of the most advanced biological science, organic and inorganic appear but relative terms, like heat and cold. There are all degrees of heat, and there are probably all degrees of life. There are probably degrees of life too low in the scale for our discernment, just as there is heat where our senses report only cold. If there are degrees of consciousness, why may there not be degrees of life? The child grows gradually into consciousness, just as the race has grown gradually into consciousness. Dare we affirm that in either case the leap from the unconscious to the conscious was or is suddenly made? No more dare we affirm that the leap from the inorganic to the organic was suddenly made. Is the crystal absolutely dead? See it shape itself according to a special plan, see how sensitive it is to the surrounding medium; see it grow when the proper food is given it, so to speak. Pasteur has noted that it cicatrizes or repairs itself when wounded. When placed in the fluid of crystallization, as in the animal, the injured part sears over and gradually regains its original shape.

The most advanced science of our time does not regard life as a special and separate principle, a real entity which has been added to matter, but as a mode in which certain physical forces manifest themselves, just as heat is not a thing of itself, but a mode of motion.

"Mechanical, chemical, and physical forces are the only efficient agents in the living organism," at least the only ones which science can recognize, and these forces are the same in both the organic and the inorganic worlds.

Behold a fire, a conflagration; see it leap and climb, witness its fierce activity, its all-devouring energies! How like a thing of life it is! Is there a unique and original principle at work here, the principle or spirit of fire, a thing apart from the intense chemical activity which it occasions? The ancient observers believed so, and it is a pretty fancy, but science recognizes in it only another of the protean forms in which force clothes itself. We can evoke fire without the aid of fire, but the fire called life man has not yet been able so to evoke—probably never will be able. The nearest he has as yet come to it is in producing many of the organic compounds synthetically from inorganic compounds—a triumph a few years ago thought to be impossible.

The barrier, then, between the organic and the inorganic, upon which the scheme of theology of Professor Drummond turns, is by no means a fixed conclusion of science. Science believes that the potencies or properties of life are on the inorganic side, and that the passage has actually taken place in the past or may still take place in the present.

In working out his general thesis, our author takes courage from the example of Walter Bagehot, whose physical politic, he says, is but the extension of natural law to the political world; and from the example of Herbert Spencer, whose biological sociology is but the application of natural law to the social world. But the political world of Walter Bagehot and the social world of Herbert Spencer are worlds which science recognizes; they fall within its pale; their existence is never disputed. But the spiritual world of Professor Drummond is a world of which science can know nothing. It is to science just as fanciful or unreal as the spiritual world of Grecian or Scandinavian mythology, or as the fairy world of childhood.

It is true the world of art, the world of genius, the world of literature, is a very select and limited affair too; but does anybody ever call the reality of it in question? Do we want proof that Shakespeare and Milton are poets? But science does want proof, if the matter comes to that, that the typical Puritan has the favor of any spiritual powers not known to the rest of mankind—not known and equally accessible to Zeno, or Plutarch, or Virgil, or Marcus Aurelius.

It is just these exceptions, these departures from the established course of Nature, that the natural philosopher is skeptical about. If an obscure event, which happened in Judea over eighteen hundred years ago, added a new kingdom to Nature, or inaugurated a new or higher order of spiritual truths impossible before that time, impossible to Plato or Plutarch, he wants the fact put in harmony with the rest of our knowledge of the universe. It is commonly believed that the course of Nature is independent of historical events, and that the ways of God to man from the beginning have been just what they are to-day.

What perpetually irritates the disinterested reader of Drummond's book is the assumption everywhere met with that the author is speaking with the authority of science, when he is only echoing the conclusions of theology. Hear him on the differences between the Christian and the non-Christian :

"The distinction between them is the same as that between the organic and the inorganic, the living and the dead. What is the difference between a crystal and an organism, a stone and a plant? They have much in common. Both are made of the same atoms. Both display the same properties of matter. Both are subject to the same physical laws. Both may be very beautiful. But, besides possessing all that the crystal has, the plant possesses something more—a mysterious something called life. This life is not something which existed in the crystal only in a less developed form. There is nothing at all like it in the crystal. . . . When from vegetable life we rise to animal life, here again we find something original and unique—unique at least as compared with the animal. From animal life we ascend again to spiritual life. And here also is something new, something still more unique. He who lives the spiritual life has a distinct kind of life added to all the other phases of life which he manifests—a kind of life infinitely more distinct than is the active life of a plant from the inertia of a stone. . . . The natural man belongs essentially to this present order of things. He is endowed simply with a higher quality of the natural animal life. But it is life of so poor a quality that it is not life at all. 'He that hath not the Son *hath not life;* but he that hath the Son hath life'—a new and distinct and supernatural endowment. He is not of this world, he is of the timeless state of eternity. *It doth not yet appear what he shall be.*"

In the chapter on classification this distinction is further elaborated, and a picture drawn of the merely moral or upright man, that leaves him very low down indeed in the scale of life, when contrasted with the Scotch Presbyterian. He is still a stone compared with the plant: "Here, for example, are two characters, pure and elevated, adorned with conspicuous virtues, stirred by lofty impulses, and commanding a spontaneous admiration from all who look upon them—may not this similarity of outward form be accompanied by a total dissimilarity of inward nature?" And he adds that the difference is really as profound and basal as that between the organic and the inorganic.

As rhetoric, or as theology, one need care little for all this; but when it is uttered as science, as it is here, it is quite another matter. When it is declared that a man, say like Emerson, when compared with the general of the Salvation Army, is a crystal compared to a flower, and the declaration is made in the name and with the authority of science, it is time to protest. In fact, to aver that the finest specimens of the race who lived before the advent of Christianity, or who have lived since, and honestly withheld their assent from the Calvinistic interpretation of it, came short of the higher life and the true destiny of man, as much as the stone comes short of the plant, may do as the personal opinion of a Scotch professor, but to announce such an opinion as the result of a scientific demonstration is an insult to science and an outrage upon human nature.

It is told of Dr. Johnson that he once silenced an old Billingsgate fish-wife by calling her a parallelogram. Professor Drummond calls the merely moral man a hexagon (see chapter on classification), and there is just as much science in the one case as in the other. It is a mere calling of names, and the retort in both cases is liable to be, "You're another!" That there is a fundamental difference between the crystal and the cell we all know, but to call Plato or Marcus Aurelius a crystal, and Luther or Calvin living organism, is purely gratuitous. To science Paul is no more alive than Plato. Both were master-spirits, both made a deep and lasting impression upon the world, both are still living forces in the world of mind to-day. Theology may see a fundamental difference between the two, but science does not. Theology may attach its own meanings to the terms life and death, but science can attach but one meaning to them, the meaning they have in the universal speech of mankind. Theology may say that "he that hath the Son hath life, and he that hath not the Son hath not life"; but is the statement any more scientific than it would be to say, "He that hath Confucius hath life, and he that hath not Confucius hath not life"? If Christ was the life in a biological and verifiable sense, then the proposition would carry its own proof. But the kind of life here referred to is a kind entirely unknown to science. The language, like the language of so much else in the New Testament, is the language of mysticism, and is not capable of verification by any process known to science. The facts that confirm it, if facts there are, lie entirely outside of the domain of scientific inquiry, direct or indirect.

As a matter of fact, and within the range of scientific demonstration, the difference between the Christian and the non-Christian, between the moral and the orthodox citizen, in our day, is as little as the difference between Whig and Tory, or Republican and Democrat—a difference of belief and of outward observance, and in no sense a fundamental difference of life and character. Is it probable that a scientific commission could establish any essential differences, say between Professor Tyndall and Professor Drummond, any differences which the latter owed to his orthodoxy that enhanced his worth as a man, as a citizen, as a father, as a husband, or as a man of trust and responsibility, over and above the former? It would probably be found that both possessed "that inbred loyalty unto virtue" of Sir Thomas Browne which certainly is the main matter in this world, and more's the pity if it is not the main matter in the next.

Our professor's argument from analogy breaks down on nearly every page by his confounding the particular with the universal, and substituting the exceptional, the hypothetical, for the natural and provable. The error is the same as if Bishop Butler had sought to prove from the *general* course of Nature, such as the changing of worms into flies, the hatching of eggs into birds, the passage of infancy into manhood, etc., that some *particular* men were endowed with immortal souls and lived after the dissolution of the body. But the bishop made the two sides of his equation equal; he started with the universal and he ended with the universal, and claimed immortality for *all* men. Drummond, on the other hand, seeks to prove a particular and exceptional fact by its analogy to a general law of Nature. In his chapter on "Conformity to Type," the leading idea is that every kind of organism conforms to the type of that which begat it: the oak to the oak, the bird to the bird, etc. An incontrovertible statement, certainly. Now, what is the analogy? This, namely, that all Christians conform to the Christ-type, and are not begotten by themselves, but by Christ. Where is the *force* of the analogy? One fails to see it, because the argument proceeds from the universal to the particular again; a principle which is true of all birds, and all oaks, is true of only some men. All men are not Christians. Moreover, Professor Drummond urges that they can not all be Christians, and that the scheme of Christianity does not require or intend that they shall all be Christians.

To give the analogy force requires that the law be as general in the one case as in the other. Every bird is a bird unconditionally; it is born a bird and dies a bird, and can be nothing else but a bird; and to show the same universal law of conformity to type, working in both cases, every man must be a Christian on the same terms: it must be shown to be the law of his being from which there is no escape. If one man fails to become a Christian, the law is broken as truly as if a bird's egg were to hatch out a mouse, or an acorn to produce a cabbage. But, in the scientific Calvinism of Professor Drummond, every bird is not a bird; only one here and there has the bird-form thrust upon it. The number of Christians is of necessity very limited. Salvation, and hence immortality, are for the few, not for the many. Our Christian philosopher is actually driven by the necessities of his argument into maintaining the truth of a special and limited immortality. Immortality is not for the whole human race, any more than the principle of life is for the whole inorganic kingdom.

"Some mineral, but not all, become vegetable; some vegetable, but not all, become animal; some animal, but not all, become human;

some human, but not all, become divine." But the principle is the same, as if all mineral did become vegetable, etc. It *may* become vegetable, probably in its turn will become vegetable ; there is no partiality or preference on the part of Nature. The same in the higher spheres. All men are approximately divine, such men as Plato and Paul vastly more so, of course, than the great mass of men ; but the difference is one of degree, not of kind, like the difference between the half-fliers and the perfect fliers among the birds. Yet Professor Drummond dare affirm that certain members of a species are endowed with a *kind* of life which is denied to certain other members of the same species, and he makes this declaration, not in the name of theology, but in the name of science !

Far be it from me to seek to belittle or discredit the true Christian life of any man or woman—the life that conforms, however imperfectly, to the example set by Jesus of Nazareth.

What I urge is, that the natural philosopher is bound to consider such a life as not contingent upon a certain belief, or the acceptance of certain dogmas, or upon any one historical event, but that it has been possible to man in all ages, and is more possible now than it was in the time of Socrates, only by virtue of the force of the teachings, and of the immortal example of the founder of Christianity.

To the impartial observer such a man as Julian the Apostate appears as about the best Christian of his time, although he utterly abjured Christianity, and was a pagan to the last drop of his blood. To be a Christian, in the higher sense, is to live a certain life, not to subscribe to a certain creed ; or, in the words of Milton (though Milton would probably have repudiated this application of his words), it is to "dare to think, to speak, and to be that which the highest wisdom has in every age taught to be best."

It may not be amiss for me to supplement or qualify the foregoing pages with a page or two which have a different bearing. In the first place, let me say that I have not so much spoken for myself therein as I have spoken for that attitude of mind which makes science or exact knowledge possible—a state of mind which, in our time, I am aware, is carrying things with a high hand. I know full well that science does not make up the sum-total of life ; that there are many things in this world that count for more than exact knowledge. A noble sentiment, an heroic impulse, courage, and self-sacrifice—how all your exact demonstrations pale before these things ! But I recognize the fact that within its own sphere science is supreme, and its sphere is commensurate with human reason ; and that, when an appeal is made to it, we must abide by the result. Theology assumes to be a science, the science of God, and as such the evidence, the proof upon which it relies, must stand the test of reason, or be capable of verification. Religion, as a sentiment, as an aspiration after the highest good, is one thing; but, formulated into a system of theology and assuming to rest upon exact demonstration, is quite another. As such it is exposed to the terrible question, Is it true? In other words, it comes within the range of science, and must stand its fire. When miracles are brought forward as an evidence of the truth of Christianity, the natural philosopher is bound to ask, Do miracles take place?

If our life were alone made up of reason or of exact knowledge, science would be all in all to us. So far as it is made up of these things, science must be our guide. But probably four fifths of life is quite outside of the sphere of science; four fifths of life is sentiment. The great ages of the world have been ages of sentiment; the great literatures are the embodiments of sentiment. Patriotism is a sentiment; love, benevolence, admiration, worship, are all sentiments.

Man is a creature of emotions, of attractions, and intuitions, as well as of reason and calculation. Science can not deepen your love of country, or of home and family, or of honor or purity, or enhance your enjoyment of a great poem or work of art, or of an heroic act, or of the beauty of Nature, or quicken your religious impulses. To know is less than to love; to know the reason of things is less than to be quick to the call of duty. Unless we approach the Bible, or any of the sacred books of antiquity, or the great poems, or Nature itself—a bird, a flower, a tree—in other than the scientific spirit, the spirit whose aim is to express all values in the terms of the reason or the understanding, we shall miss the greatest good they hold for us. We are not to approach them in a spirit hostile to science, but with a willingness to accept what science can give, but knowing full well that there is a joy in things and an insight into them which science can never give. There is probably nothing in the Sermon on the Mount that appeals to our scientific faculties, yet there are things here by reason of which the world is vastly the gainer. Indeed, nearly all the recorded utterances of Christ rise into regions where science can not follow. "Take no thought of the body." "He that would save his life shall lose it." "Except ye become as little children, ye can not enter the kingdom of heaven," etc. These things are in almost flat contradiction of the precepts of science.

It may be noted that Christ turned away from or rebuked the more exact, skeptical mind that asked for a sign, that wanted proof of everything, and that his appeal was to the more simple, credulous, and enthusiastic. He chose his disciples from among this class, men of faith and emotion, not too much given to reasoning about things. In keeping with this course of action, nearly all his teachings were by parables. In fact, Christ was the highest type of the mystical, parable-loving, Oriental mind, as distinguished from the exact, science-loving, Occidental mind.

Let us not make the mistake of supposing that all truth is scientific truth, or that only those things are true and valuable which are capable of verification by the reason or by experience. Truth has many phases, and reaches us through many channels. There is a phase of truth which is apprehended by what we call taste, as poetic truth, literary truth; another phase which is felt by the conscience, as moral truth; and still another, which addresses the soul as the highest spiritual and religious truths. All these are subjective truths, and may be said to be qualities of the mind, but they are just as real for all that as the objective truths of science. These latter are the result of a demonstration, but the former are a revelation in the strict sense. Such a poet as Wordsworth, such a writer as Emerson, speaks to a certain order of minds. In each case there is a truth which is colored by, or rather is the product of the man's idiosyncrasy. In science we demand a perfectly colorless, transparent medium; the personality of the man must be kept out of the work, but in poetry and in general literature the personality of the man is the chief factor. The same is true of the great religious teachers; they give us themselves. They communicate to us, in a measure, their own exalted spirituality. The Pauline theology, or the theology which has been deduced from the teachings of Paul, may not be true as a proposition in Euclid is true, but the sentiment which animated Paul, his religious fervor, his heroic devotion to a worthy cause, were true, were real, and this is stimulating and helpful. Shall we make meat and drink of sacred things? Shall we value the Bible only for its literal, outward truth? Convince me that the historical part of the Bible is not true, that it is a mere tissue of myths and superstitions, that none of those things fell out as there recorded; and yet the vital, essential truth of the Bible is untouched. Its morals, its ethics, its poetry are forever true. Its cosmology may be entirely unscientific, probably is so, but its power over the human heart and soul remains. Indeed, the Bible is the great deep of the religious sentiment, the primordial ocean. All other expressions of this sentiment are shallow and tame compared with the briny deep of the Hebrew Scriptures. What storms of conscience sweep over it; what upreaching, what mutterings of wrath, what tenderness and sublimity, what darkness and terror are in this book! What pearls of wisdom it holds, what gems of poetry! Verily, the Spirit of the Eternal moves upon it. Whether, then, there be a personal God or not, whether our aspirations after immortality are well founded or not, yet the Bible is such an expression of the awe, and reverence, and yearning of the human soul in the presence of the facts of life and death, and of the power and mystery of the world, as pales all other expression of these things; not a cool, calculated expression of it, but an emotional, religious expression of it. To demonstrate its divergence from science is nothing; from the religious aspirations of the soul it does not diverge.

What I wish to say, therefore, is that we are conscious of emotions and promptings that are of deeper birth than the reason, that we are capable of a satisfaction in the universe quite apart from our exact knowledge of it, and that the religious sentiment of man belongs to this order of truths. This sentiment takes on various forms; the forms themselves are not true, but the sentiment is. To recur to my former illustration of the constellations—however fantastic the figures which the soul has pictured upon the fathomless dome, the stars *are* there; the religious impulse remains.

It is perhaps inevitable that systems should arise, that creeds should be formed, and that the name of science should be invoked in their behalf, but the wise man knows they are perishable, and that the instinct that gave them birth alone endures. What is the value of this instinct? It would be presumption for me to attempt to estimate it, or to hope to disclose its full significance. Its history is written in the various ethnic religions, often written in revolting forms and observances. But it tends more and more to purify itself, rises more and more toward the conception of the fact that the kingdom of heaven is within and not without; and this purification has, in our day, unquestionably been forwarded by what we call science.

ZOÖLOGICAL SUPERSTITIONS.

By FELIX L. OSWALD, M. D.

POPULAR sciences resemble the forest-plants that can flourish without the aid of systematic culture, but that advantage is offset by their liability to excrescences in the form of popular superstitions. During the middle ages thaumaturgy, or the study of the supernatural, enjoyed for centuries an all but universal popularity, and the luxuriance of its products almost suffocated all better germs of the human mind. For, by a curious law of primogeniture, the vitality of such spontaneous sprouts far exceeds that of the most carefully grafted scions. In natural history, for instance, many brilliant theories have appeared and disappeared like meteors, while popular delusions flicker with the persistency of a blazing tar-barrel.

The authority of Scripture (1 Kings, x, 22) warrants the belief that monkeys formed an article of commerce as much as twenty-eight centuries ago, so that no lack of time can have prevented us from studying the habits of our four-handed relatives; yet it would hardly be an overestimate to say that nine hundred and ninety-nine of a thousand men persist in the belief that monkeys have a passion for imitating the actions of their two-handed kinsmen; that, for instance, an ape, seeing his master shave himself, would take the first opportunity to get hold of a razor and scrape or cut his own throat. Now, how could that idea ever survive this age of zoölogical gardens? Marcus Aurelius held that the sum of all ethics was the rule to "love truth and justice, and live without anger, in the midst of lying and unjust men."

Yet the occupation of a monkey-trainer would put that tolerance to a severe test. With an intelligence surpassing that of the most intelligent dog, a monkey combines an ultra-mulish degree of obstinacy, and, rather than imitate the demonstrative manipulations of the kindest instructor, he will sham fear, sham lameness, sham heart-disease, and generally wind up by falling down in a sham fit of epileptic convulsions. I have owned monkeys of at least twenty different species, and have never been able to discover the slightest trace of that supposed *penchant* for mimicry. A boy may take off his coat and turn a thousand somersets, Jacko will watch the phenomenon only with a view to getting his fingers into the pockets of the unguarded coat. Lift up your hand a hundred times, Jacko will witness the proceeding with calm indifference, unless a more emphatic repetition of the manœuvre should make him duck his head to dodge an anticipated blow. He has no desire to follow any human precedents whatever, and the apparent exceptions from that rule are, on his part, wholly unintentional and merely a natural result of anatomical analogies. An angry hamadryas baboon, for instance, will strike the ground with his fist, not because any Christian visitors have ever set him that bad example, but because his forefathers have thus for ages vented their wrath on the rocks of the Nubian highlands. A capuchin monkey will pick huckleberries with his fingers, not in deference to civilized customs, but because his fingers are deft and long, and his jaws very short. Nay, that same capuchin monkey, admitted to a seat at the breakfast-table of a punctilious family, would be apt to show his contempt of court by sticking his head in the pudding-dish. The compulsive methods of professional trainers may modify that perversity, but during recess the redeemed four-hander is sure to drop his mask, and, unlike a trained dog, will never volunteer the performance of a popular trick.

About the beginning of this century an ingenious Frenchman traveled about with a so-called chess-automaton, a wooden figure with movable arms, manipulated by a hidden accomplice, and warranted to play chess according to the rules of Devega's manual. As a mystifying joke, the contrivance was quite a success, and, if any intelligent person could really believe in the autonomy of the apparatus, the silliness of the idea could hardly have surpassed the absurdity of the parrot-stories which our popular family journals continue to retail in this age of reason. Not more than a year ago, some modern Buffon, after a learned disquisition on the comparative intelligence of beasts and birds, treated his readers to the following "characteristic" anecdote: A Philadelphia family bought a parrot which could sing four or five national hymns, but to the dismay of his Quaker proprietor proved to have a still greater genius for blasphemous slang. Family worship and the conversation of learned and pious visitors were apt to be interrupted by a sudden cataract of Billingsgate, till the head of the family ordered the bird, at the first sign of profanity, to be ducked in a pailful of cold water. The specific answered its purpose, and one rainy day the parrot was sitting in the open kitchen-window, watching the events of the back yard, where he espied a number of drenched chickens, picking their way across the slippery pavement. "Poor things!" said Polly, and then in an undertone, as the chickens approached the house—"Look here, you've been swearing, haven't you?" This probable story made the rounds of the American press, and is a fair sample of hundreds of similar myths. The truth is, that the wisest parrot ever shipped from Pará to New York does not connect the slightest meaning with the best-remembered word of his vocabulary. Properly speaking, elocutionary birds do not *talk* at all. They only repeat. They rehearse phrases as they would rehearse a tune, and one might as well credit a telephone with the ability of originating a logical combination of words. If profanity is a sin, swearing parrots will be forgiven, because they know not what they do; but their jokes are equally unintended. A phrase, repeated a thousand times a day, can not, of course, be used *always* malapropos, but the rarity of the exceptions confirms the rule as decidedly as the lucid interval of a Salvation Army dragoon. In one of Anderson's fairy-tales, the night wind tries to reveal a secret to a man who happens to understand only the dialect of his native village, and thus hears nothing but the whistling of the reeds and the rustling of the leaves; and in the wisest human speech poor Poll hears only the hooting of vowels and the clacking of consonants.

The serpent-charm superstition, too, still holds its own, though a recent communication to the "Scientific American" seems to imply that at least one common-sense explanation of the phenomenon begins to elucidate the fog of mysticism. The writer, evidently a practical naturalist, suggests that the apparent infatuation of "charmed" birds may be nothing but the heroism of maternal affection, overcoming the instinct of self-preservation. That inference may not rarely hold good in the spring-time of our northern woodlands, but squirrels and lizards, as well as birds, are charmed, and in October as often as in May; and the champions of the wizard-theory might at any time test the matter by a simple experiment. Venomous serpents are the most sluggish of all reptiles (compare "Popular Science Monthly," September, 1879), and, with a bag-net fastened to a ring and tied to the end of a long stick, a rattlesnake can be captured more easily than a butterfly. Quarter your captive in a convenient out-house and let him starve for a couple of days. Then procure a lot of rats, or good-sized mice, such as every mill-boy is ready to deliver for a dime a dozen. Do not introduce them all at once, but successively, and fastened to a string at the end of a stick. The apathy of the snake can be broken by making the mouse scamper in tempting proximity to his fangs. Give the poison time to operate, and watch the conduct of the victims; but observe the precaution of removing them just as the serpent approaches to enjoy the fruits of her victory. The next time she will commence hostilities with a promptness evincing her wrath at the failure of her former attempts. Some five or six successive encounters (though each following discharge of poison may in some degree weaken the effect of the next bite) will thus prove that the supposed magic influence of the serpent's eye is nothing but the after-effect of a not strictly instantaneous poison. The flexible poison-fangs of the serpent do not enable her to hold her prey at the first snap, but she can afford to bide her time, well knowing that the beginning of the end is only a question of a few minutes. During the last of those minutes the victims may behave in a most singular, though under the circumstances noways abnormal, manner; and I will agree to sign Jean Bodin's dissertation on the disadvantages of natural explanations, if any thaumaturgist, with a lingering vestige of common sense, should fail to admit the conclusiveness of the experiment.

The serpent-charm delusion is probably nothing but an outcome of the evil-eye superstition, which in mediæval Italy ranked almost as an article of faith. In the same country poison-mongery had then attained the perfection of an exact science. In Naples there were experts who could specify the day when a tincture of *Aqua tofana*, repeated in a certain number of doses, would overcome the vitality of the toughest constitution. Cæsar Borgia could fetch his man by a mere scratch of a finger-ring. Many of those artists may have studied the subsequent appearance of their victims with a searching look, more apt to attract attention than the furtive administration of the deadly drug. If the victim died, his fate was ascribed to the influence of the *mal occhio*, a mystic gift which made its possessor an object of dread and envy, but of which the law could not properly take cognizance. The snap-bite, administered perhaps in the tangle of a bramble-bush, has escaped attention; the temporary escape of the victim obliges the serpent to sally from its hiding-place and watch the effect of the dose. At that stage of proceedings the conduct, both of the bird and the snake, is apt to attract the notice of a passer-by, who associates the then visible phenomena—the fixed gaze of the serpent, and the abnormal motions of the bird—thus mistaking a coincident circumstance for the cause of an effect.

Exactly the same mistake has cost the lives of thousands of harmless birds of the family *Picidæ*. Woodpeckers live upon the larvæ of various species of noxious insects, and haunt dead trees where such insects most abound: hence the extremely prevalent delusion connecting the activity of woodpeckers with the decay of trees. In the language of the backwoodsmen the tree-cleaner has become a tree-destroyer, a "sap-sucker," a name actually applied to the *Picus pubescens*, or speckled woodpecker, of the North American forests.

In a similar way the beneficent functions of the bat are still repaid with the ingratitude of the chief beneficiary. Bats catch mosquitoes, bats catch night-butterflies, the parents of millions of noxious caterpillars, but, in default of a convenient cave, are apt to make their headquarters in smoke-stacks, and thus incur the suspicion of bacon-curing housewives :

> "Bat, bat, fly in my hat,
> And I'll give you some bacon-fat,"

is the popular stanza, preluding a shower of whistling brickbats, if the poor cheiropter ventures to leave his den before dark. And yet the *bona fide* petting of bats would, in many countries, be the best remedy of the mosquito-plague. There are few parts of Eastern Arkansas where the utmost diligence in ditching and draining would abate the torment of the perennial gnat-swarms, and in many swamp-districts of Southern Mexico one might as well try to bar out rats with a rail-fence as gnats with a mosquito-bar, since the forty or fifty different varieties comprise several sizes that could slip through the meshes of a cambric handkerchief, while the largest kind would as easily bite through a flannel night-shirt. Yet in the midst of such a swamp-delta I once passed a comfortable night in the loft of an old cotton-mill. We had neither gauze-bars nor smoke-pots, but two large *louvres* at opposite ends of the loft stood wide open, and all night the whispering of the land-breeze mingled with the fluttering and the clicking chirp of busy bats, but rarely as much as the incipient buzz of a tipulary insect.

The tenacity of the most preposterous tenets, as compared with that of less irrational delusions, is curiously illustrated by two zoölogical superstitions which North America seems to have imported from the northern nations of the Old World. A hundred years ago nine out of ten American colonists believed firmly in the existence of two remarkable vertebrates : the "joint-snake," a reptile gifted with the faculty of joining and disjoining its organism like a combination pen-holder ; and the "glutton," a "monstre able to devore the carcaes of black cattle," as Sir Douglas of Glastonbury informs us.

The latter superstition has been traced to a singular international origin. The Norwegian *Fjell-frit*, or mountain-whelp, was mistaken for a *Viel-frass* by the same nation that turned a reindeer into a Rennthier ("race-beast"), and this incorrect "much-eater" was correctly translated into a French *glouton* and an English glutton, which the Latinizers, with their *penchant* for "characteristics," specified as a *gulo luscus*, just as the wolf-fish, or sea-cat of the Scotch fishermen, was made an *anarrhichas*, from a supposed dexterity in climbing rocks by means of its jagged fins. Encouraged by a solecism thus well indorsed, the first glutton-hunters of our continent reveled in miracle-legends.

"The Western trappers," says Colonel Ruxton ("Adventures in Mexico and the Rocky Mountains," page 278), "give most wonderful accounts of an animal which, though exceedingly rare, is occasionally met with in the mountains, but, from its supposed ferocity and the fact of its being a cross between the devil and a bear, is given a wide berth whenever it makes its dreaded appearance. Most startling stories were told of its audacity: how it has been known to leap upon a hunter and devour him in a twinkling; often charging furiously into a camp and playing all sorts of pranks on the goods and chattels of the mountaineers. The general belief was, that the animal owes its paternity to the old gentleman himself; the most reasonable declaring it to be a cross between the bear and wolf. Hunting one day with an old Canadian trapper, he told me that, in a part of the mountains which we were about to visit, his comrades once had a battle with a 'carcagieu,' which lasted upward of two hours, during which they fired a pouchful of balls into the animal's body, which spat them out as fast as they were shot in! Two days after, as we were toiling up a steep ridge after a band of mountain-sheep, my companion, who was in advance, suddenly threw himself flat behind a rock and exclaimed in a smothered tone, signaling me with his hand to keep down and conceal myself, 'Sacré enfant de Gârce, mais here's von dam carcagieu!' I immediately cocked my rifle, and, advancing to the rock and peeping over it, saw an animal, about the size of a large badger, engaged in scraping up the earth about a dozen paces from where we were concealed. From its appearance I at once recognized the mysterious quadruped to be a 'glutton.' After I had sufficiently examined the animal, I raised my rifle to shoot, when a louder than common 'Enfant de Gârce!' alarmed the animal, and it immediately ran off, when I stood up and fired both barrels after it, but without effect, the attempt exciting a derisive laugh from the Canadian, who exclaimed: 'Pe gar, may be you got fifty balls; vel, shoot 'em all at de dam carcagieu, and he not care a dam!'"

But, after all, the foundation dogma, the existence of a wolf-like animal of prodigious voracity, was less insane than incorrect, and as such was renounced without regret. The joint-snake idiocy, on the other hand, though knocked to pieces a hundred times, persists in reviving with symbolic promptitude. In the Rocky Mountains, on the lower Mississippi, and all through the southern Alleghanies, farmers and hunters still believe in the self-reconstructive power of a reptile that survives dismemberment with the facility of a New York tramway ring, and, after picking up a jaw-bone here and a couple of vertebræ there, pursues its way rejoicing, and ready to segregate again at a minute's notice. Time-honored dogmas are ridicule-proof; and how shall we, in this special case, avail ourselves of Schopenhauer's maxim that the best way of refuting a superstition is to explain it? Should the strange delusion be founded on the habit of certain ophidians that make the pit of their œsophagus a place of refuge for their new-born offspring? Dozens of young snakelets have been seen crawling into the open jaws of the *Cerastes berus* and the *Clotho arietas*, and, according to Burmeister, also of certain pythons. But more probably the superstition is nothing but a product of that myth-making faculty that evolves a queer egg into a basilisk, and supplements a strange death by a still stranger resurrection. A correspondent of "Home and Farm" describes a number of brittle snakes and invertebrate snake-like worms "as easily broken as tallow-candles, *and about as hard to mend.*" Lizards, too, break at the mere touch of a switch and scamper off, leaving a tail-end wriggling in the grass. In some phenomenon of that sort the wonder-mania of our miracle-fuddled ancestors may have seen a glorious chance for insulting common sense by the elaboration of the joint-snake myth.

THE HIGHER EDUCATION OF WOMAN.

By Mrs. E. LYNN LINTON.

ON all sides the woman question bristles with difficulties, and the higher education is one of them. The excess of women over men—reaching to not far from a million—makes it impossible for all to be married—Mormonism not being our way out of the wood. At the same time, this paucity of husbands necessitates the power of self-support for those women of the unendowed classes who are left penniless on the death of the bread-winner, and who must work if they would eat. This power of self-support, again, must be based on broad and honorable lines, and must include something that the world really wants and is content to pay for. It must not be a kind of well-masked charity if it is to serve the daughters of the professional class—women who are emphatically gentle, not only by birth, but by that refinement of habit and delicacy of sentiment which give the only true claim to the comprehensive term of lady. These women must be able to do something which shall not lower their social status and which shall give them a decent income. They must keep in line with their fathers and brothers, and be as well-considered as they. Certainly, they have always had the office of teachers; but all can not be schoolmistresses or governesses, and the continual addition made to the number of candidates for work demands, and has already opened, other avenues and fresh careers. And—but on this no one can help save women themselves—as teachers and governesses they are not generally treated as on an equality with their employers, and are made to feel that to gain money, even by their brains, lowers their social status and reduces them perilously near to the level of the servants. As authoresses or artists they may hold their own; the glamour of "fame" and "genius" gilding over the fact that they make their incomes and do not draw them, and have nothing capitalized—not even their own reputations.

Of late years this question of woman's work has passed into another phase, and the crux now is, not so much how they can be provided with work adequately remunerated, but how they can fit themselves for doing it without damage to their health and those interests of the race and society which are bound up with their well-being. This is the real difficulty, both of the higher education and of the general circumstances surrounding the self-support of women. For the strain is severe, and must be, if they are to successfully compete with men—undeniably the stronger, both in mind and body, in intellectual grasp and staying power, in the faculty of origination, the capacity for sustained effort, and in patient perseverance under arduous and it may be distasteful labor. But the dream and the chief endeavor of women now is to do the same work as men alone have hitherto done—which means that the weaker shall come into direct competition with the stronger—the result being surely a foregone conclusion. This is the natural consequence of the degradation by women themselves of their own more fitting work; so that a female doctor, for the present, holds a higher social position than does the resident governess, while a telegraph-girl may be a lady, but a shop-girl can not.

For well-paid intellectual work a good education is naturally of the first necessity, and the base on which all the rest is founded. Wherefore, the higher education has been organized more as a practical equipment than as an outcome of the purely intellectual desire of women to learn where they have nothing to gain by it. For all this, many girls go to Girton and Newnham who do not mean to practically profit by their education—girls who want to escape from the narrow limits of the home, and who yearn after the quasi-independence of college-life—girls to whom the unknown is emphatically the magnificent, and who desire novelty before all things; with the remnant of the purely studious—those who love learning for its own sake only, independent of gain, *kudos*, freedom, or novelty. But these are the women who would have studied as ardently, and with less strain, in their own homes; who would have taken a longer time over their education, and would not have hurt their health and drained their vital energies by doing in two or three years what should have taken five or six; who would have gathered with more deliberation, not spurred by emulation nor driven by competition; and who, with energy superadded to their love of knowledge, would have made the Mrs. Somervilles or Caroline Herschels, the Miss Burneys or Harriet Martineaus, of history. But such women are not many; voluntary devotion, irrespective of self-interest, to art, literature, science, philosophy, being one of the rarest accidents in the history of women—as, indeed, must needs be if they are to fulfill the natural functions of their sex.

Three important points come into this question of the higher education of women. These are—1. The wisdom or unwisdom for a father of limited means and uncapitalized income to send to college, at great expense, girls who may marry, and so render the whole outlay of no avail. 2. The effect which this higher education has on the woman and the individual. 3. The physical results on her health and strength, especially in relation to her probable maternity.

To give a good education to a boy is to lay the foundations, not only for a successful individual life, but also those for a well-conditioned family. It is the only thing a man can do who has no fortune to leave his son, and is, in fact, a fortune under another form. With a good education, and brains to profit by it, nothing is impossible. From the Prime Minister to the Lord Chancellor, from the Archbishop of York to the leader of the House of Commons, a clever lad, well educated, has all professional possibilities before him—as the French private has the marshal's *bâton* in his knapsack. But to go to the like expense for the education of a daughter is by no means the same investment, nor can it be made to produce the same return. Where the man's education enables him to provide for his family, a woman's may be entirely thrown away for all remunerative results to herself and others. Indeed, it may be hurtful rather than beneficial. At the best—taking things by their rule and not by their exceptions—it is helpful to herself only; for the women of the professional class, like those of the laboring, support only themselves. For which cause, we may say parenthetically, they are able to undercut the men, and can afford to work for less than can those who have wives and children to support. And this is the reason—again parenthetically—why men try to keep them out of certain trades; seeing in them not so much honest competitors for so much work, as the ultimate destroyers of the home and the family itself. In the education, too, of his sons a father discriminates and determines according to their future. The boy intended for commerce he does not usually send to college; nor is stress laid on Latin or Greek or art or literature at school. For the one destined to the law or the church he stipulates for a sound classical training, and ultimately sends him to the university. For the artist he does not demand science; for the engineer he does not demand music—and so on. Almost all boys who have their own way to make are educated with a distinct reference to their future work; and wise men agree on the folly of wasting time and force on useless acquirements, with corresponding neglect of those which are useful. But how can girls be educated in this special manner? What professions are open to them as to men? The medical alone of the three learned, public opinion not yet being ripe for barristers in petticoats or for women preachers regularly ordained and beneficed; while the army and navy are still more closely shut against those ambitious amazons who think there should be no barriers against them in the barrack-yard or on the quarter-deck, and that what any individual woman can do she should be allowed to do, general rules of prohibition notwithstanding. The higher education gives us better teachers, more accurate writers, and our scantling of medical women. But, if a girl is not to be one of these three things, the money spent on her college career will be emphatically wasted, so far as relates to the wise employment of funds in reference to a remunerative future.

And then there is always that chance of marriage, which knocks the whole thing to pieces; save in those exceptional cases where two students unite their brains as well as their fortunes, and the masculine M. A. marries the feminine, for the better perfecting of philosophic literature. Even in this rare instance the fact of marriage nullifies the good of the education; and, after a father has spent on his daughter's education the same amount of money as would have secured the fortune of a capable son, it can not give him retrospective satisfaction to see her married to some one who will make her the mother of a family, where nothing that she has gained at so much cost will tell. Her knowledge of Greek and German will not help her to understand the management of a nursery; nor will her ability to solve all the problems of Euclid teach her to solve that ass's bridge of domestic economy—the co-ordination of expenditure with means, and the best way of extracting the square root of refinement out of that appalling x of insufficiency.

To justify the cost of her education a woman ought to devote herself to its use, else does it come under the head of waste; and to devote herself to its use she ought to make herself celibate by philosophy and for the utilization of her material, as nuns are celibate by religion and for the saving of their souls. As things are, it is a running with the hare of self-support and hunting with the hounds of matrimony—a kind of trusting to chance and waiting on the chapter of accidents, which deprives this higher education of anything like noble stability in results, making it a mere cast of the die which may draw a prize or throw blank. But very few women would elect to renounce their hope of marriage and maternity for the sake of utilizing their education, or would voluntarily subordinate their individual desire to that vague thing, the good of society. On this point I shall have something to say further on. Yet this self-dedication would be the best answer to those who object to the higher education for the daughters of struggling professional men, because of the large chance there is of its ultimate uselessness. It would give, too, a social purpose, a moral dignity, a philosophic purity, and a personal earnestness to the whole scheme which would make it solid and organic, instead of, as now, loose and accidental.

So far as we have yet gone, has this higher education had a supremely beneficial effect on the character of women themselves? As intelligences, yes; as women, doubtful. We are not now taking the individual women who have been to Girton or Newnham, but the whole class of the quite modern advanced women. These are the direct product of the movement which has not only given us female doctors and superior teachers, but female orators, female politicians, and female censors all round—women who claim for themselves the leadership of life on the ground of a superior morality and clearer insight than have men. In dealing with the woman question, we can never forget the prominent characteristics of the sex—their moral vanity, coupled with their love of domination. The great mass of women think they know better than they can be taught; and on all moral questions claim the highest direction and the noblest spiritual enlightenment. Judging from sentiment and feeling, they refuse the testimony of facts; the logic of history has no lesson for them, nor has any unwelcome science its rights or its truths. They are Anglo-Israelites, but not the products of evolution; and ghosts are real where germs are imaginary. This sentiment, this feeling, is like some other things, a good servant but a bad master. When backed by religious faith it stops at no superstition; when backed by moral conviction, it is a tyranny under which the free energies of life are rendered impossible; when backed by a little knowledge, it assumes infallibility. Scarcely a week passes without some letter in the papers, wherein an imperfectly educated woman attacks a master in his profession, on the ground of her sentiment as superior to his facts—her spiritual enlightenment the Aaron's rod which swallows up his inferior little serpents of scientific truths. This restless desire to shoot with all bows—Ulysses', Nestor's, whose one will—may be, and probably is, the first effervescence of a ferment which will work itself clear by time and use. It is to be hoped so; for the pretensions to supremacy, by reason of their superiority, of women in these later times is not one of the most satisfactory results of the emancipation movement. And they can not be too often reminded that the higher education, with all that this includes, is not meant to supersede their beautiful qualities, but only to strengthen their weak intellectual places and supply their mental deficiencies.

It would not be for the good of the world were the sentiment and tenderness of women to be lost in their philosophic calmness. But as little is it for the advantage of society when that sentiment rules rather than influences, shapes rather than modifies. That old adage about two riding on horseback together, when one must ride behind, is getting a new illustration. Hitherto the man was in front. It was thought that he was the better fitted to both discern the dangers ahead and receive the first brunt of such blows as might be about, while the woman crouched behind the shield of his broad body; and in return for that protection left the reins in his hands and did not meddle with the whip—or if she did, then was she censured while he was ridiculed. Now, things are changing; and on all sides women are seeking to dispossess the men of their places to take them for themselves. In the home and out of the home woman's main desire is for recognized leadership, so that man shall live by their rule. The bed of Procrustes was no myth; we have it in full working activity at this present time.

We come now to the third and most important point, the physical results of the educational strain in relation to maternity. On this head we will take Dr. Withers-Moore as our guide, in his speech made at the British Association on the 11th of August. The pith of his position is in this sentence, "Bacon's mother (intellectual as she was) could not have produced the 'Novum Organum,' but she, perhaps she alone, could and did produce Bacon." The same may be said of Goethe's mother. She could not have written "Faust," but she formed and molded and influenced the man who did. In almost all the histories of great men it is the mother, and not the father, whose influence and teaching are directly traceable; and it is a remark as trite as the thing is common, that great men do not often produce great sons, but almost all great men have notable mothers. As the "Oxford tutor," quoted by Dr. Withers-Moore, said, "A man's fate depends on the nursing—on the mother, not the father. The father has commonly little to do with the boy till the bent is given, and the foundation of character laid. All depends on the mother." And this means not only her moral influence, but the actual shaping and molding force of her physical condition reacting on his. Following this are the opinions of experts and philosophers who have given time and thought to the subject; and in all the authorities quoted—fourteen in number—there is the same note of warning against overstudy in girls who are one day to be mothers. It is an unwelcome doctrine to those who desire above all things to be put on an absolute equality with men; who desire to do man's special work, while leaving undone their own; who will not recognize the limitations of sex nor the barriers of Nature; who shut their eyes to the good of society and the evil which may be done by individuals; and who believe that all who would arrest a movement fraught with danger to the whole are actuated by private motives of a base kind, and are to be treated as enemies willfully seeking to injure, rather than as friends earnestly desirous of averting injury. Dr. Withers-Moore's summary of the whole question bearing on the physical condition of women as mothers is this:

> Excessive work, especially in youth, is ruinous to health, both of mind and body; excessive brain-work more surely so than any other. From the eagerness of woman's nature, competitive brain-work among gifted girls can hardly but be excessive, especially if the competition be against the superior brain-weight and brain-strength of man. The resulting ruin can be averted—if it be averted at all—only by drawing so largely upon the woman's whole capital stock of vital force and energy as to leave a remainder quite inadequate for maternity. The Laureate's "sweet girl graduate in her golden hair" will not have in her the fulfillment of his later aspiration—
>
> "May we see, as ages run,
> The mother featured in the son."
>
> The human race will have lost those who should have been her sons. Bacon,

for want of a mother, will not be born. She who should have been his mother will perhaps be a very distinguished collegian. That one truism says it all—women are made and meant to be, not men, but mothers of men. A noble mother, a noble wife—are not these the designations in which we find the highest ideal of noble womanhood? Woman was formed to be man's helpmate, not his rival; heart, not head; sustainer, not leader.

The ideal mother is undoubtedly a woman more placid than nervous in temperament, more energetic than restless in habits, and with more strength of character and general good sense than specialized intellectual acquirements. Strong emotions, strained nerves, excitement, anxiety, absorption, are all hurtful to the unborn child. They tend to bring on premature birth; and if not this, then they create sickly offspring, whom the mother can not nourish when they are born. And, speaking of this, I may as well state here that the number of women who can not nurse their own children is yearly increasing in the educated and well-conditioned classes; and that coincident with this special failure is the increase of uterine disease. This I have from one of our most famous specialists. The mental worries and the strain of attention inseparable from professional life make the worst possible conditions for satisfactory child-bearing; while the anxiety bound up with the interruption to her work, consequent on her health and changed condition, must tell heavily on the nerves and mind of the woman whose professional income counts in the family. Her physical troubles, of themselves quite enough to bear, have thus extra weight; and mind, nerves, work, and condition, act and react in a vicious circle all round. Even where her profession is one that does not take her out-of-doors, and does not involve any great personal fatigue—as literature or art—the anxiety of her work and the interruption which must needs result from her state are more disastrous to the unborn than to herself; and the child suffers as much from the relaxation as from the strain. As one of the wisest and best-trained women I know said to me the other day: "How much of all the grand force and nervous power, the steadiness and courage of Englishmen, may not be owing to the fact of the home-life and protection of women; and how much shall we not lose when the mothers of the race are rendered nervous, irritable, and overstrained by the exciting stimulus of education carried to excess, and the exhausting anxieties of professional competition!"

This does not say that only the "stupid women" are therefore to be wives and mothers. Specialized education does not necessarily create companionable nor even sensible women; else, by parity of reasoning, would all professional men be personally charming and delightful, which undoubtedly they all are not. A girl may be a sound Grecian, a brilliant mathematician, a sharp critic, a faultless grammarian, yet be wanting in all that personal tact and temper, clear observation, ready sympathy, and noble self-control which make a companionable wife and a valuable mother. Nor is unprofessional or unspecialized instruction necessarily synonymous with idleness and ignorance; while a good all-round education is likely to prove more serviceable in the home and in society than one or two supreme accomplishments. Many of us make the mistake of confounding education with acquirements, and of running together mental development and intellectual specialization. The women of whom we are most proud in our own history were not remarkable for special intellectual acquirements so much as for general character and the harmonious working of will and morality. The Lady Fanshawes and Elizabeth Frys, the Mary Carpenters and Florence Nightingales, whose names are practically immortal, were not noted for their learning, but they were none the less women whose mark in history is indelible, and the good they did lives after them, and will never die. And taking one of the, at least, partially learned ladies of the past—is it her Latinity and her bookishness that we admire so much in Lady Jane Grey; or is it her modesty, her gentleness, her saintly patience, her devotion?—in a word, is it her education or her character?—the intellectual philosopher, or the sweet and lovely and noble woman?

Modern men want intelligent companions in their wives. But the race demands in its turn healthy, wise, and noble mothers of vigorous children. Only a few of the less worthy men desire simply an upper servant for domestic use, or a mistress for personal pleasure, or both in one, with whom they, the husbands, feel no true comradeship. But do the mass of men want the specialized companionship of a like education? Does not human nature rather desire a change—the relaxation of differences?—and do specialists want to be always talking to their wives of literature, art, science, medicine, law—whatever may be their own assigned work? Would they not rather forget the shop, even though that shop be the library or the studio, and pass into a fresh intellectual atmosphere when they lay aside their MSS. or fling down their brushes? We must always remember, too, that the conduct and management of the house and family belong to women; and that, if the wife and mother does not actively superintend those departments which the fitness of things has apportioned to her, subordinates must—subordinates who will not put into their work either the love or the conscience of the wife, whose interests are identical with her husband's—of the mother, with whom reason and instinct, education and affection, create that half-divine power to which most great men have owed the chief part of their greatness.

Not going all the length of the Turkish idea that women are born into the world only to be the wives and mothers of men—as mothers of women simply keeping up the supply, and that for themselves they are of no account outside their usefulness to and relations with men—it is yet undeniably better that they should be unnoted as individuals and perfect as mothers, rather than famous in their own persons and the mothers of abortive and unsatisfactory children. In this lies the soul of the controversy; for the whole question is contained in the relative importance of individual rights and social duties—freedom for self-development in such direction as may suit ourselves, or subordinating our personal desires to the general and unindividualized good.

We are in the midst of one of the great revolutions of the world. The old faiths are losing their hold and the new are not yet rooted; the old organization of society is crumbling to pieces and we have not even founded, still less created, the new. In this revolution, naturally one of the most prominent facts is the universal claim for individual freedom, outside the elemental laws which hold the foundations together, made by every one alike. We preach the doctrine of rights everywhere, that of duties straggles in where it can; and the one crying need of the world at this moment is for some wise and powerful organizer who shall recombine these scattered elements and reconstruct the shattered edifice. Women, who always outstrip their leaders, are more disorganized, because at this time they are even more individualized, than are men. Scarcely one among them takes into account the general good. Even in those questions where they have made themselves the leaders, individual victories are of greater value than general policy, and they would always subordinate the practical welfare of the majority to the sentimental rights of the minority. An individual sorrow moves them where the massed results of a general law leave them cold. This characteristic is perfectly sound and righteous in those to whom have been confided the care of the family and the arrangement of details. Women ought to be individual, not for themselves but for others; and in that individualism there ought to be the injustice inseparable from devotion. An altruistic mother who would sacrifice her one child for the sake of her neighbor's two does not exactly fulfill our ideas of maternal care; on the other hand, a mother who would rather her son was disgraced as a coward than that he should run the dangers of courage, or the partisan of her own sex who would sacrifice twenty men to save one woman inconvenience or displeasure, is as little fit to be the leader of large movements involving many and varied interests as is that other to be a mother. In their own persons women carry out to a very remarkable degree this principle of individualism, the general good notwithstanding. Speak to an ordinary woman of the evil economic effects of her actions, and you speak a foreign language. She sees only the individual loss or gain of the transaction, and a public or social duty to creatures unknown and unseen does not count. In the cruel vicissitudes of fashion and the ruin of thousands brought about by simple change of material—in the selfish greed for bargains, no matter at whose cost obtained—in the complete ignoring of and indifference to all the results to others of her own example, a woman of the ordinary type is essentially individual and unsocial. In America—whence, however, we have received so many grand and noble impulses—this female individualism, with its corresponding indifference to the public good or to public duty, is even more pronounced than here; and the right of woman to her own development, though that should include what is called "the painless extinction of man," is the very heart and soul of the new creed.

Women, seeking to rule, have forgotten how to obey. Wishing to reorganize society according to their own desires, they have at the same time thrown off all sense of discipline in their own lives; and the former feminine virtues of devotion, patience, self-suppression, and obedience are flung aside as so much tarnished finery of a decayed and dishonored idol. The ordinary woman can not be got to see that she is not only herself but also a member of society and part of an organization; and that she owes, as a duty to the community, the subordination of her individualism to that organization. She understands this only in religious communities, where she obeys her director as one divinely commissioned. Outside religious discipline she refuses obedience to general principles. Society has grown so large and its disorganization is so complete that, she says to herself, her own example does not count. She is but a fractional part of a grain added to a ton-weight; and by the law of psycho-dynamics she is undiscerned and without influence. It is all very well in small communities, like those of Greece for instance, or when the one grand lady of the village was the mirror for all to dress by. Then, the individual example was of value; but now—who cares for one out of the tens of thousands crowded in London; and what duty has she to the community comparable to that which she owes herself?

And this brings us round once more to the subject-matter of this paper—the effect on the community of the higher education of women, in its good and evil results on mothers and their offspring, and their own indifference to these results.

It is impossible not to sympathize with a bright girl anxious to go on with her education, and petitioning for leave to study higher matters than have been taught her at her school. It is as impossible not to feel a sense of indignation at the injustice when parents say frankly the education of their girls does not count with them; and, so long as these know how to read and write and can play the piano and are able to dance and perhaps to sew, there is nothing more necessary. We do battle then for the right of the individual to know, to learn, to perfect itself to the utmost of its ability, irrespective of sex. But if we are wise we stop short of such strain as would hurt the health and damage the reproductive energies, if marriage is to come into one of the chances of the future. A girl is something more than an individual; she is the potential mother of a race; and the last is greater and more important than the first. Let her learn by all means. Let her store her mind and add to her knowledge, but always with quietness and self-control—always under restrictions bounded by her sex and its future possible function. Or, if she disregards these restrictions, and goes in for competitive examinations, with their exhausting strain and feverish excitement—if she takes up a profession where she will have to compete with men and suffer all the pain and anxiety of the unequal struggle—let her then dedicate herself from the beginning as the vestal of knowledge, and forego the exercise of that function the perfection of which her own self-improvement has destroyed. We can not combine opposites nor reconcile conflicting conditions. If the mental strain consequent on this higher education does waste the physical energies, and if the gain of the individual is loss to the race, then must that gain be sacrificed or isolated.

Of course, it all depends on that if; and of this experts are the only trustworthy judges. We must be guided by the better knowledge of specialists and those who have studied in all its bearings a subject of which we know only one side, and that side the one turned to our own desire. If one examiner * reports that "of the boys twenty-nine per cent, and of the girls forty-one per cent, were found to be in a sickly state of health"; if another, † in confirmation, says that "11·6 per cent of boys and girls in the St. Petersburg schools suffer from headache," we must suppose there is something to be taken note of in the opposition of most medical men to this higher education of women. For we must put out of court, as unworthy of serious consideration, that old, well-worn accusation of man's opposition to woman's advancement from jealousy, tyranny, the desire of domination, and the preference of slaves and mistresses over companions and wives. We must accept it as part of all sane argument that people desire the best—ideas as to what is the best differing according to the point of view; as now in this very question under consideration, where the individual gain clashes with the good of the community, and the personal advantage of the woman hurts her usefulness as a mother. We must acknowledge, too, that experts know better than the unlearned; and that, in matters of health and the wisest rules for physical well-being, medical men are safer guides than girls ambitious for their own distinction, or women ambitious for their sex—holders, too, of the doctrine of absolute equality in mental strength with men, and of free trade in all employments and careers.

A great deal of the difficulty surrounding the question of woman's employment could be got over by women themselves. If, instead of degrading their own more natural work by the social ostracism of the workers, they would raise it by respect and honor, large fields of productive usefulness would be opened and much cause for heart-burning would cease. The greater democracy of the present age makes it pos-

* Dr. Hertel, speaking of over-pressure in the high-schools of Denmark.

† Professor J. N. Bystroff. Both quoted by Dr. Withers-Moore in his speech at the British Association.

sible for great ladies to earn money. Even a queen throws her books into the market, and sells them all the same as others. A generation or so ago no lady could have made money, save by the two methods of painting and writing—both done within the sacred seclusion of the four walls of home. Actresses were what we call in the north "chancey." Some were thoroughly respectable, and came to good ends and high positions ; but the bulk were best left alone by women who wished to keep alive anything like veneration for virtue. Now, however, we have opened all gateways, and made it possible for ladies of condition, repute, and birth to do what they will in the way of money-making and still retain both character and position. A princess opens a milliner's shop ; a lady of rank is a cow-keeper and profits by her dairy-farm ; women of title go on the stage ; ladies of gentle birth and breeding are storekeepers and horse-breeders. But as yet these are only the showy —we had almost said theatrical—and quasi-romantic vanguard ; and what we want is a stable condition of self-support for women whose inherited position is not of that high class which no work can degrade, but who, ladies as they are, stand or fall according to the arbitrary estimation of their work.

In this, we repeat, no one can help women save women. Certain tailors and certain shopkeepers are received in London society as among its favorite and most honored guests. Do we meet with a milliner, a lady shopkeeper? Do we not all know milliners and dressmakers who are well-educated, pleasant-mannered, honorable ladies ; yet would the countesses and dames for whom they devise their dainty costumes agree to meet them on equal terms at balls and dinners? Why not? Surely it can not be on the ground of making their own money. The highest ladies in the land do not disdain to turn an honest penny if they can ; and where, pray, is the essential difference between the clergyman's daughter who sells mantles or laces in a shop for her living and the young duchess who sells pincushions and button-holes at a bazaar for her vanity, masked as charity? Here, if we will, the principle of individualism would work with advantage. If we could get rid of all caste feeling, and judge of people by themselves and not by their work—if we would allow that a milliner could be a lady, and a shop-girl on a level with her sister the governess, and both on an equality with their brother the clergyman and their aunt the physician's wife—we should have done more for the question of the employment of women than we have done by the establishment of colleges and the creation of educational standards, the attainments of which are inimical to the best interests of society because hurtful to women themselves. We must do what we can in this life, not always what we would ; and the general interests of society are to be considered before those of a special section, by whose advancement will come about the corresponding degeneracy of the majority.

In these two propositions, then, we think the whole thing lies—in voluntary celibacy for those who overtax their vital energies by an intellectual strain that hurts the offspring; and in the honoring of those lighter and easier methods of making money which have hitherto condemned a woman to social ostracism, and denied her the status she deserves and has inherited.—*Fortnightly Review.*

ENERGY IN PLANT-CELLS.

By Professor T. H. McBRIDE.

FEW people have any true conception either of the kind or amount of actual energy displayed in the life and growth of a simple plant. In ordinary experience the manifestations of vital energy are always associated with the activity of some animal. Life in the animal seems at its best; its forces are more concentrated, hence more vivid in display, and in every way appeal more certainly to our attention. An animal can move, can exhibit strength, can do work, hence has force, exhibits energy—vital energy, if you please. But in the plant-world these forces are less noted, although going on in much the same way to the accomplishment of life's purposes; and, if less obtrusive in their action and simpler in behavior, are also less difficult to study and easier to understand. To see where some of these forces are exerted, how they are manifested and how controlled, is, in so far as circumstances may allow, the purpose of this article.

The most patent display of energy on the part of a plant is in connection with the growth. Every one knows how a growing seed will send a shoot to the surface through a hard covering of overlying earth. And above-ground the tip of the growing plantlet persistently defies gravitation. Roots find their way through the interstices of clay, and crowd into the enlarging crevices of rocks. The bark of a tree, under tension, in equilibrium of pressure and resistance as long as the tree lives, evinces an energy very appreciable in amount. The amount of force concerned in this case we are not left to imagine, but may at least approximately estimate.

Along the highway that passes one of our Iowa farms were planted many years ago a row of soft-maple trees, designed to serve at length as posts for carrying the wires of the fence. When the trees attained suitable size they were put to the use intended by nailing to each tree a piece of pine lumber four feet long and two by four inches in section for the better attachment of the wires. Since the erection of the fence in the way indicated, the growth of the trees has produced some very striking results. The blocks were attached to the trees by heavy iron spikes (Fig. 1). These seem to have rusted into the tree, and by their points to have held firmly, while by the continual deposition of new layers the tree has crowded off the block, drawing the head of the spike directly through the pine wood; that is, new material has been thrust in between the wood of the tree on the one hand and the block on the other, until the block has been fairly wedged from its place. Now, it is asserted on excellent authority that the force necessary to accomplish this result amounts to a pressure of about thirty pounds to the square inch; i. e., the forces of growth in a soft maple are capable of exerting in all directions a force of thirty pounds to the square inch. Now, these results may seem somewhat surprising, but our surprise is in no degree lessened when we begin to study the machinery by which this energy is exerted. If we could make a cross-section of one of the trees in question, we should find by far the greater part of the tree in a condition of nearly absolute fixity, incapable of enlargement in any direction. Outside is the bark, likewise largely incapable of exerting force, most of the cells having long since yielded up their living matter. Only on the line of division separating bark from wood do we find a structure whose cells are capable of life, growth, and multiplication. This structure is so thin that only the finest line would be needed for its delineation, were we to draw the whole section, natural size (Fig. 2). Furthermore, this layer is made of cells whose walls are exceedingly delicate and thin. So much more feeble, in this regard, are the cells here than on either side, that this layer, the cambium, is the line of separation when, in the growing season, you easily strip the green bark from the wood. The energy, then, which we have estimated, must finally rest upon these thin-walled, delicate cells. Not only is this true, but we may also easily conclude that all the pressure by which the cleat is wedged from the tree must come from the growth and multiplication of the same diminutive organisms. It is plain here that the force concerned is not capillary, for that is certainly as active in the woody parts of the tree as in the cambium, there producing no expansion whatever. Neither does it seem that the energy expended must be attributed to osmosis, although the cell may be by construc-

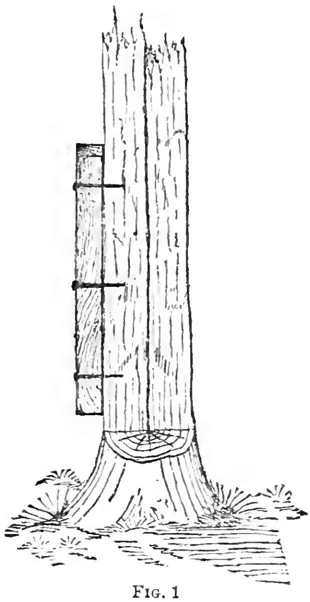

Fig. 1

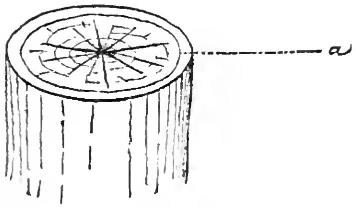

Fig. 2.—Cross-Section of an Exogenous Stem.

tion a simple osmotic apparatus. Osmosis there undoubtedly is, but it is exactly similar here to osmosis everywhere, and, while accounting for certain things as capillarity accounts for certain other things, still does not mean growth. Let us see what osmosis can do. If two liquids of unequal density be separated by a membrane pervious to either or both, an interchange between the two fluids occurs until equilibrium of density is established, the greater quantity of the commingled fluids being found at last on that side of the membrame at first occupied by the denser fluid. Suppose now, for illustration, a chain of cells extending from some leaf on the maple-tree down to some rootlet in contact with a drop of water, each cell-content of less density than that above it, and we should have a current setting toward the leaf, and likewise, though less in energy and amount, a current in the opposite direction. Certainly, something of this kind actually happens, not in a single row of cells, but involving all active cells of the tree, so that water from the soil is carried to the leaf, and the products of the latter are diffused throughout the organism. We may even conceive the cells beneath our block of wood to be distended to repletion by the process just described, yet all this is not growth. Given this machinery at the beginning of our experiment, and we can see that the connection of the block would be strained as when wooden wedges, by absorbing water, burst the rock. But the cells once distended, the limit of pressure is reached, and everything would remain in *statu quo*. And now appears the energy of life's forces. After osmosis and diffusion have done their best, the living matter of the cell is able, notwithstanding the pressure, to enlarge the cells, increase their number, and thicken their walls, and this it is that at length produces the phenomenon we have seen, and brings the spikes, heads and all, through the yielding wood.

But let us look at another example illustrating this same thing. In the manufacture of beer, as every one knows, the alcohol of the beverage is produced by fermentation, a process induced through the activity of brewer's yeast. Now, brewer's yeast, as may be shown by any good microscope, consists essentially of minute single cells, each of which is capable of performing alone all vital functions; i. e., each cell can assimilate food, grow, and reproduce its kind—the two functions last named being here, as elsewhere, dependent on the first. The food of the yeast-cell in this instance is grape-sugar or glucose. From this comes as a sort of by-product of assimilation carbon dioxide in large quantities. The liberation of this gas in the wort produces the frothing which constitutes so noticeable a feature of fermentation. The glucose being the source of supply whence the gas is eliminated, it is plain, all questions of temperature aside, that gas will appear so long as glucose remains in sufficient quantity to nourish the yeast. The amount of glucose found in different grades varies, but certain it is that no beer is entirely free from this yeast-food, so that, when the brewer is ready to deliver his beer to the customer, he is painfully aware that his goods are in anything but stable condition. Hence beer for shipment is placed in oak quarter-barrels (kegs), bound with many broad iron hoops, and made by shape and in every way as stout and strong as possible. Prior to filling at the brewery, beer-kegs are subjected to water-pressure of thirty-five pounds to the square inch, and yet, notwithstanding care in construction and rigor in the test applied, beer-kegs will once in a while actually burst; i. e., the strain caused by internal pressure passes (probably far surpasses) the limit of the test. Here then, again, we have a gauge by which to estimate the energy of life's forces. The pressure is due to the evolution of gas; but the gas, as has been said, is disengaged only as a consequent of vitality, of growth, and, at the moment preceding the explosion, the cells are acting, the processes of growth accomplishing, under a pressure of not less than forty or fifty pounds to the inch. The yeast-cell grows, pushes forth bud after bud, liberates particle after particle of carbon dioxide, all under increasing pressure the further the process goes, until at last at the supreme moment oak and iron can endure no more—the barrel bursts! Here no one can quote osmosis, although as between the contents of the cell and the surrounding liquid osmosis doubtless there is, as there was in the case of the maple; but osmosis is certainly not responsible for the gas-pressure under which the cells are working.

The illustrations cited certainly establish the truth of the proposition with which we began, viz., that plant-cells may display actual appreciable energy. Indeed, it would seem that no one could look in upon the living streams of any transparent, active cell, as these sweep within narrow limits in tireless ebb and flow, and not be convinced that in some way at least life is the exponent of force. What that force may be, no one can positively as of knowledge say. If we affirm that the energy of the plant-cell is to be traced to the sun's rays, we state but a partial truth. The sunlight simply continues an energy already started, simply keeps the machinery wound up, or rather prevents its running down, and we can conceive of no cell whose primary energy is not derived directly from the nearest link of the infinite chain preceding.

Take now into consideration what we may call the directive energy of the cell (call it accumulated habit, hereditary endowment, or what you will), which determines the direction and the limits of the cell's growth, which locks within the compass of a single bit of protoplasm the destiny of millions of succeeding living atoms, combining to the accomplishment of most wonderful and varied functions, so that every germ-cell at the least has its own individuality, its own future, its own ideal, into which in the order of Nature it comes, and we begin to see that, even were the physical energies of the cell cleared up, we are yet as far off as ever from the solution of life's problem. As Emerson puts it, "Life is life which *generates*," and generation implies an energy to which all other energy in a living cell yields homage.

In thus measuring the energy which cells exert, it seems to me we lay our finger on the very pulse of the living world; we *feel* the push of its ceaseless stream, and in the impact of the latest wave catch the full force of that primal impulse in which life's history on earth began.

GEOLOGY OF THE ATLANTIC OCEAN.*

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II.

THUS far our discussion has been limited almost entirely to physical causes and effects. If we now turn to the life-history of the Atlantic, we are met at the threshold with the question of climate, not as a thing fixed and immutable, but as changing from age to age in harmony with geographical mutations, and producing long cosmic summers and winters of alternate warmth and refrigeration. We can scarcely doubt that the close connection of the Atlantic and Arctic Oceans is one factor in those remarkable vicissitudes of climate experienced by the former, and in which the Pacific area has also shared in connection with the Antarctic Sea. No geological facts are indeed at first sight more strange and inexplicable than the changes of climate in the Atlantic area, even in comparatively modern periods. We know that in the early Tertiary perpetual summer reigned as far north as the middle of Greenland, and that in the Pleistocene the Arctic cold advanced until an almost perennial winter prevailed half-way to the equator.

It is no wonder that nearly every cause available in the heavens and the earth has been invoked to account for these astounding facts. It will, I hope, meet with the approval of your veteran glaciologist, Dr. Crosskey, if, neglecting most of these theoretical views, I venture to invite your attention in connection with this question chiefly to the old Lyellian doctrine of the modification of climate by geographical changes. Let us, at least, consider how much these are able to account for. The ocean is a great equalizer of extremes of temperature. It does this by its great capacity for heat and by its cooling and heating power when passing from the solid into the liquid and gaseous states, and the reverse. It also acts by its mobility, its currents serving to convey heat to great distances or to cool the air by the movement of cold, icy waters. The land, on the other hand, cools or warms rapidly, and can transmit its influence to a distance only

* From the inaugural address of the President of the British Association for the Advancement of Science, delivered at Birmingham, England, September 1, 1886.

by the winds, and the influence so transmitted is rather in the nature of a disturbing than of an equalizing cause. It follows that any change in the distribution of land and water must affect climate, more especially if it changes the character or course of the ocean-currents.

At the present time the North Atlantic presents some very peculiar and, in some respects, exceptional features, which are most instructive with reference to its past history. The great internal plateau of the American Continent is now dry land ; the passage across Central America between the Atlantic and Pacific is blocked ; the Atlantic opens very widely to the north ; the high mass of Greenland towers in its northern part. The effects are that the great equatorial current running across from Africa and embayed in the Gulf of Mexico is thrown northward and eastward in the Gulf Stream, acting as a hot-water apparatus to heat up to an exceptional degree the western coast of Europe. On the other hand, the cold Arctic current from the polar seas is thrown to the westward, and runs down from Greenland past the American shore. The pilot chart for June of this year shows vast fields of drift-ice on the western side of the Atlantic as far south as the latitude of 40°. So far, therefore, the glacial age in that part of the Atlantic still extends ; this at a time when, on the eastern side of the ocean, the culture of cereals reaches in Norway beyond the Arctic Circle.

Let us inquire into some of the details of these phenomena. The warm water thrown into the North Atlantic not only increases the temperature of its whole waters, but gives an exceptionally mild climate to Western Europe. Still, the countervailing influence of the Arctic currents and the Greenland ice is sufficient to permit icebergs which creep down to the mouth of the Strait of Belle Isle, in the latitude of the south of England, to remain unmelted till the snows of a succeeding winter fall upon them.

Now let us suppose that a subsidence of land in tropical America were to allow the equatorial current to pass through into the Pacific. The effect would at once be to reduce the temperature of Norway and Britain to that of Greenland and Labrador at present, while the latter countries would themselves become colder. The northern ice, drifting down into the Atlantic, would not, as now, be melted rapidly by the warm water which it meets in the Gulf Stream. Much larger quantities of it would remain undissolved in summer, and thus an accumulation of permanent ice would take place, along the American coast at first, but probably at length even on the European side. This would still further chill the atmosphere, glaciers would be established on all the mountains of temperate Europe and America, the summer would be kept cold by melting ice and snow, and at length all Eastern America and Europe might become uninhabitable, except by Arctic animals and plants as far south as, perhaps, 40° of north latitude.

This would be simply a return of the glacial age. I have assumed only one geographical change; but other and more complete changes of subsidence and elevation might take place, with effects on climate still more decisive; more especially would this be the case if there were a considerable submergence of the land in temperate latitudes.

We may suppose an opposite case. The high plateau of Greenland might subside or be reduced in height, and the openings of Baffin's Bay and the North Atlantic might be closed. At the same time the interior plain of America might be depressed, so that, as we know to have been the case in the Cretaceous period, the warm waters of the Mexican Gulf would circulate as far north as the basins of the present great American lakes. In these circumstances there would be an immense diminution of the sources of floating ice, and a correspondingly vast increase in the surface of warm water. The effects would be to enable a temperate flora to subsist in Greenland, and to bring all the present temperate regions of Europe and America into a condition of subtropical verdure.

It is only necessary to add that we know that vicissitudes not dissimilar from those above sketched have actually occurred in comparatively recent geological times, to enable us to perceive that we can dispense with all other causes of change of climate, though admitting that some of them may have occupied a secondary place. This will give us, in dealing with the distribution of life, the great advantage of not being tied up to definite astronomical cycles of glaciation, which may not always suit the geological facts, and of correlating elevation and subsidence of the land with changes of climate affecting living beings. It will, however, be necessary, as Wallace well insists, that we shall hold to that degree of fixity of the continents in their position, notwithstanding the submergences and emergences they have experienced, to which I have already adverted. We can now more precisely indicate this than was possible when Lyell produced his "Principles," and can reproduce the conditions of our continents in even the more ancient periods of their history. Some examples may be taken from the history of the American Continent, which is more simple in its arrangements than the double continent of Europ-Asia. We may select the early Devonian or Erian period, in which the magnificent flora of that age—the earliest certainly known to us—made its appearance.

Imagine the whole interior plain of North America submerged, so that the continent is reduced to two strips on the east and west, connected by a belt of Laurentian land on the north. In the great Mediterranean sea thus produced, the tepid water of the equatorial current circulated, and it swarmed with corals, of which we know no less than one hundred and fifty species, and with other forms of life appropriate to warm seas. On the islands and coasts of this sea was introduced the Erian flora, appearing first in the north, and with that vitality and colonizing power of which, as Hooker has well shown, the Scandinavian flora is the best modern type, spreading itself to the south. A very similar distribution of land and water in the Cretaceous age gave a warm and equable climate in those portions of North America not submerged, and coincided with the appearance of the multitude of broad-leaved trees of modern types introduced in the early and middle Cretaceous, and which prepared the way for the mammalian life of the Eocene.

We may take a still later instance from the second continental period of the later Pleistocene or early modern, when there would seem to have been a partial or entire closure of the North Atlantic against the Arctic ice, and wide extensions seaward of the European and American land, with possibly considerable tracts of land in the vicinity of the equator, while the Mediterranean and the Gulf of Mexico were deep inland lakes. The effect of such conditions on the climates of the northern hemisphere must have been prodigious, and their investigation is rendered all the more interesting because it would seem that this continental period of the post-glacial age was that in which man made his first acquaintance with the coasts of the Atlantic, and possibly made his way across its waters. We have in America ancient periods of cold, as well as of warmth.

I have elsewhere referred to the bowlder conglomerates of the Huronian, of the Cambrian and Ordovician, of the millstone-grit period of the Carboniferous and of the early Permian ; but would not venture to affirm that either of these periods was comparable in its cold with the later glacial age, still less with that imaginary age of continental glaciation assumed by certain of the more extreme theorists. These ancient conglomerates were probably produced by floating ice, and this at periods when in areas not very remote temperate floras and faunas could flourish.

The glacial periods of our old continent occurred in times when the surface of the submerged land was opened up to the northern currents, drifting over it mud and sand and stones, and rendering nugatory, in so far at least as the bottom of the sea was concerned, the effects of the superficial warm streams. Some of these beds are also peculiar to the eastern margin of the continent, and indicate ice-drifts along the Atlantic coast in the same manner as at present, while conditions of greater warmth existed in the interior. Even in the more recent glacial age, while the mountains were covered with snow, and the lowlands submerged under a sea laden with ice, there were interior tracts in somewhat high latitudes of America in which hardy forest-trees and herbaceous plants flourished abundantly ; and these were by no means exceptional "interglacial" periods. Thus we can show that, while from the remote Huronian period to the Tertiary the American land occupied the same position as at present, and while its changes were merely changes of relative level as compared with the sea, these have so influenced the ocean-currents as to cause great vicissitudes of climate.

Without entering on any detailed discussion of that last and greatest glacial period which is best known to us, and is more immediately connected with the early history of man and the modern animals, it may be proper to make a few general statements bearing on the relative importance of sea-borne and land ice in producing those remarkable phenomena attributable to ice-action in this period. In considering this question it must be borne in mind that the greater masses of floating ice are produced at the seaward extremities of land glaciers, and that the heavy field-ice of the Arctic regions is not so much a result of the direct freezing of the surface of the sea as of the accumulation of snow precipitated on the frozen surface.

In reasoning on the extent of ice-action, and especially of glaciers in the Pleistocene age, it is necessary to keep this fully in view. Now, in the formation of glaciers at present—and it would seem also in any conceivable former state of the earth—it is necessary that extensive evaporation should conspire with great condensation of water in the solid form. Such conditions exist in mountainous regions sufficiently near to the sea, as in Greenland, Norway, the Alps, and the Himalayas ; but they do not exist in low Arctic lands like Siberia or Grinnell-land, nor in inland mountains. It follows that land glaciation has narrow limits, and that we can not assume the possibility of great confluent or continental glaciers covering the interior of wide tracts of land. No imaginable increase of cold could render this possible, inasmuch as there could not be a sufficient influx of vapor to produce the necessary condensation ; and the greater the cold, the less would be the evaporation. On the other hand, any increase of heat would be felt more rapidly in the thawing and evaporation of land ice and snow than on the surface of the sea.

Applying these very simple geographical truths to the North Atlantic continents, it is easy to perceive that no amount of refrigeration could produce a continental glacier, because there could not be sufficient evaporation and precipitation to afford the necessary snow in the interior. The case of Greenland is often referred to, but this is the case of a high mass of cold land with sea, mostly open, on both sides of it, giving, therefore, the conditions most favorable to precipitation of snow. If Greenland were less elevated, or if there were dry plains around it, the case would be quite different, as Nares has well shown by his observations on the summer verdure of Grinnell-land, which, in the immediate vicinity of North Greenland, presents very different conditions as to glaciation and climate. If the plains were submerged and the Arctic currents allowed free access to the interior of the Continent of America, it is conceivable that the mountainous regions remaining out of water would be covered with snow and ice, and there is the best evidence that this actually occurred in the glacial period ;

but with the plains out of water this would be impossible. We see evidence of this at the present day in the fact that in unusually cold winters the great precipitation of snow takes place south of Canada, leaving the north comparatively bare, while as the temperature becomes milder the area of snow deposit moves farther to the north. Thus, a greater extension of the Atlantic, and especially of its cold, ice-laden Arctic currents, becomes the most potent cause of a glacial age.

I have long maintained these conclusions on general geographical grounds, as well as on the evidence afforded by the Pleistocene deposits of Canada ; and, in an address the theme of which is the ocean, I may be excused for continuing to regard the supposed terminal moraines of great continental glaciers as nothing but the southern limit of the ice-drift of a period of submergence. In such a period the southern margin of an ice-laden sea where its floe-ice and bergs grounded, or where its ice was rapidly melted by warmer water, and where, consequently, its burden of bowlders and other *débris* was deposited, would necessarily present the aspect of a moraine, which, by the long continuance of such conditions, might assume gigantic dimensions. Let it be observed, however, that I fully admit the evidence of the great extension of local glaciers in the Pleistocene age, and especially in the times of partial submergence of the land.

I am old enough to remember the sensation caused by the delightful revelations of Edward Forbes respecting the zones of animal life in the sea, and the vast insight which they gave into the significance of the work on minute organisms previously done by Ehrenberg, Lonsdale, and Williamson, and into the meaning of fossil remains. A little later the soundings for the Atlantic cable revealed the chalky foraminiferal ooze of the abyssal ocean ; still more recently the wealth of facts disclosed by the Challenger voyage, which naturalists have not yet had time to digest, have opened up for us new worlds of deep-sea life. The bed of the deep Atlantic is covered for the most part by a mud or ooze largely made up of the *débris* of foraminifera and other minute organisms mixed with fine clay. In the North Atlantic the Norwegian naturalists call this the Biloculina mud.

Farther south the Challenger naturalists speak of it as Globigerina ooze. In point of fact it contains different species of foraminiferal shells, Globigerina and Orbulina being in some localities dominant, and in others other species, and these changes are more apparent in the shallower portions of the ocean. It is also to be observed that there are means for disseminating coarse material over the ocean-bed. There are in the line of the Arctic current on the American coast great sand-banks, and off the coast of Norway, and constitute a considerable part of the bottom material. Soundings and dredgings off Great Britain, and also off the American coast, have shown that fragments of stone referable to Arctic lands are abundantly strewed over the bottom along certain lines, and the Antarctic Continent, otherwise almost unknown, makes its presence felt to the dredge by the abundant masses of crystalline rock, drifted far from it to the north.

These are not altogether new discoveries. I had inferred many years ago, from stones taken up by the hooks of fishermen on the banks of Newfoundland, that rocky material from the north is dropped on these banks by the heavy ice which drifts over them every spring, that these stones are glaciated, and that after they fall to the bottom sand is drifted over them with sufficient velocity to polish the stones and to erode the shelly coverings of Arctic animals attached to them. If, then, the Atlantic basin were upheaved into land, we should see beds of sand, gravel, and bowlders with clay flats and layers of marl and limestone. According to the Challenger reports, in the Antarctic seas south of 64°, there is blue mud with fragments of rock in depths of twelve hundred to two thousand fathoms. The stones, some of them glaciated, were granite, diorite, amphibolite, mica-schist, gneiss, and quartzite. This deposit ceases and gives place to Globigerina ooze and red clay at 46° and 47° south; but even farther north there is sometimes as much as forty-nine per cent of crystalline sand. In the Labrador current a block of syenite weighing four hundred and ninety pounds was taken up from thirteen hundred and forty fathoms, and in the Arctic current, one hundred miles from land, was a stony deposit, some stones being glaciated. Among these were smoky quartz, quartzite, limestone, dolomite, mica-schist, and serpentine; also particles of monoclinic and triclinic feldspar, hornblende, augite, magnetite, mica, and glauconite—the latter, no doubt, formed in the sea-bottom, the others drifted from Eozoic and Palæozoic formations to the north.

A remarkable fact in this connection is that the great depths of the sea are as impassable to the majority of marine animals as the land itself. According to Murray, while twelve of the Challenger's dredgings taken in depths greater than two thousand fathoms gave ninety-two species, mostly new to science, a similar number of dredgings in shallower water near the land gave no less than one thousand species. Hence arises another apparent paradox relating to the distribution of organic beings. While at first sight it might seem that the chances of wide distribution are exceptionally great for marine species, this is not so. Except in the case of those which enjoy a period of free locomotion when young, or are floating and pelagic, the deep ocean sets bounds to their migrations. On the other hand, the spores of cryptogamic plants may be carried for vast distances by the wind, and the growth of volcanic islands may effect connections which, though only temporary, may afford opportunity for land animals and plants to pass over.

With reference to the transmission of living beings across the Atlantic, we have before us the remarkable fact that from the Cambrian age onward there were on the two sides of the ocean many species of invertebrate animals, which were either identical, or so closely allied as to be possibly varietal forms. In like manner the early plants of the Upper Silurian, Devonian, and Carboniferous present many identical species; but this identity becomes less marked in the vegetation of the more modern times.

In so far as plants are concerned, it is to be observed that the early forests were largely composed of cryptogamous plants, and the spores of these in modern times have proved capable of transmission for great distances. In considering this, we can not fail to conclude that the union of simple cryptogamous fructification with arboreal stems of high complexity, so well illustrated by Dr. Williamson, had a direct relation to the necessity for rapid and wide distribution of these ancient trees. It seems also certain that some spores, as, for example, those of the Rhizocarps, a type of vegetation abundant in the Palæozoic, and certain kinds of seeds, as those named *Ætheotesta* and *Pachytheca*, were fitted for flotation. Further, the periods of Arctic warmth permitted the passage round the northern belt of many temperate species of plants, just as now happens with the Arctic flora; and when these were dispersed by colder periods they marched southward along both sides of the sea on the mountain-chains. The same remark applies to northern forms of marine invertebrates, which are much more widely distributed in longitude than those farther south. The late Mr. Gwyn Jeffreys, in one of his latest communications to this Association, stated that fifty-four per cent of the shallow-water mollusks of New England and Canada are also European, and of the deep-sea forms thirty out of thirty-five; these last, of course, enjoying greater facilities for migration than those which have to travel slowly along the shallows of the coasts in order to cross the ocean and settle themselves on both sides. Many of these animals, like the common muscle and sand-clam, are old settlers which came over in the Pleistocene period, or even earlier. Others, like the common periwinkle, seem to have been slowly extending themselves in modern times, perhaps even by the agency of man. The older immigrants may possibly have taken advantage of lines of coast now submerged, or of warm periods, when they could creep around by the Arctic shores.

Mr. Herbert Carpenter and other naturalists employed on the Challenger collections have made similar statements respecting other marine invertebrates, as, for instance, the Echinoderms, of which the deep-sea crinoids present many common species, and my own collections prove that many of the shallow-water forms are common. Dall and Whiteaves have shown that some mollusks and Echinoderms are common even to the Atlantic and Pacific coasts of North America; a remarkable fact, testifying at once to the fixity of these species, and to the manner in which they have been able to take advantage of geographical changes. Some of the species of whelks common to the

Gulf of St. Lawrence and the Pacific are animals which have no special locomotive powers even when young, but they are northern forms not proceeding far south, so that they may have passed through the Arctic seas.

In this connection it is well to remark that many species of animals have powers of locomotion in youth, which they lose when adult, and that others may have special means of transit. I once found at Gaspé a specimen of the Pacific species of *Coronula*, or whale-barnacle, the *C. reginæ* of Darwin, attached to a whale taken in the Gulf of St. Lawrence, and which had probably succeeded in making that passage round the north of America which so many navigators have essayed in vain. It is to be remarked here that while many plants and marine invertebrates are common to the two sides of the Atlantic, it is different with land-animals, and especially vertebrates.

I do not know that any fossil insects or land-snails or millipedes of Europe and America are specifically identical, and of the numerous species of batrachians of the Carboniferous and reptiles of the Mesozoic all seem to be distinct on the two sides. The same appears to be the case with the Tertiary mammals, until in the later stages of that great period we find such genera as the horse, the camel, and the elephant appearing on the two sides of the Atlantic ; but even then the species seem different, except in the case of a few northern forms. Some of the longer-lived mollusks of the Atlantic furnish suggestions which remarkably illustrate the biological aspect of these questions. Our familiar friend the oyster is one of these. The first-known oysters appear in the Carboniferous in Belgium and in the United States of America. In the Carboniferous and Permian they are few and small, and they do not culminate till the Cretaceous, in which there are no less than ninety-one so-called species in America alone ; but some of the largest known species are found in the Eocene. The oyster, though an inhabitant of shallow water, and very limitedly locomotive when young, has survived all the changes since the Carboniferous age, and has spread itself over the whole northern hemisphere. I have collected fossil oysters in the Cretaceous clays of the *coulées* of Western Canada, in the Lias shales of England, in the Eocene and Cretaceous beds of the Alps, of Egypt, of the Red Sea coast, of Judea, and the heights of Lebanon. Everywhere and in all formations they present forms which are so variable and yet so similar that one might suppose all the so-called species to be mere varieties. Did the oyster origiate separately on the two sides of the Atlantic, or did it cross over so promptly that its appearance seems to be identical on the two sides? Are all the oysters of a common ancestry, or did the causes, whatever they were, which introduced the oyster in the Carboniferous, act over again in later periods? Who can tell?

This is one of the cases where causation and development—the two scientific factors which constitute the bases of what is vaguely called evolution—can not easily be isolated. I would recommend to those biologists who discuss these questions to addict themselves to the oyster. This familiar mollusk has successfully pursued its course and has overcome all its enemies, from the flat-toothed selachians of the Carboniferous to the oyster-dredgers of the present day, has varied almost indefinitely, and yet has continued to be an oyster, unless indeed it may at certain portions of its career have temporarily assumed the disguise of a Gryphæa or an Exogyra. The history of such an animal deserves to be traced with care, and much curious information respecting it will be found in the report which I have cited. But in these respects the oyster is merely an example of many forms. Similar considerations apply to all those Pliocene and Pleistocene mollusks which are found in the raised sea-bottoms of Norway and Scotland, on the top of Moel Tryfaen in Wales, and at similar great heights on the hills of America, many of which can be traced back to early Tertiary times, and can be found to have extended themselves over all the seas of the northern hemisphere. They apply in like manner to the ferns, the conifers, and the angiosperms, many of which we can now follow without even specific change to the Eocene and Cretaceous. They all show that the forms of living things are more stable than the lands and seas in which they live.

If we were to adopt some of the modern ideas of evolution, we might cut the Gordian knot by supposing that, as like causes can produce like effects, these types of life have originated more than once in geological time, and need not be genetically connected with each other. But while evolutionists repudiate such an application of their doctrine, however natural and rational, it would seem that Nature still more strongly repudiates it, and will not allow us to assume more than one origin for one species.

Thus the great question of geographical distribution remains in all its force, and, by still another of our geological paradoxes, mountains become ephemeral things in comparison with the delicate herbage which covers them, and seas are in their present extent but of yesterday when compared with the minute and feeble organisms that creep on their sands or swim in their waters. The question remains, Has the Atlantic achieved its destiny and finished its course, or are there other changes in store for it in the future? The earth's crust is now thicker and stronger than ever before, and its great ribs of crushed and folded rock are more firm and rigid than in any previous period. The stupendous volcanic phenomena manifested in Mesozoic and early Tertiary times along the borders of the Atlantic have apparently died out. These facts are in so far guarantees of permanence. On the other hand, it is known that movements of elevation along with local depression are in progress in the Arctic regions, and a great weight of new sediment is being deposited along the borders of the Atlantic, especially on its western side, and this is not improbably connected with the earthquake-shocks and slight movements of depression which have occurred in North America. It is possible that these slow and secular movements may go on uninterruptedly until considerable changes are produced; but it is quite as likely that they may be retarded or reversed. It is possible, on the other hand, that after the long period of quiescence which has elapsed there may be a new settlement of the ocean-bed, accompanied with foldings of the crust, especially on the western side of the Atlantic, and possibly with renewed volcanic activity on its eastern margin. In either case a long time relatively to our limited human chronology may intervene before the occurrence of any marked change.

On the whole, the experience of the past would lead us to expect movements and eruptive discharges in the Pacific rather than in the Atlantic area. It is therefore not unlikely that the Atlantic may remain undisturbed, unless secondarily and indirectly, until after the Pacific area shall have attained to a greater degree of quiescence than at present. But this subject is one too much involved in uncertainty to warrant us in following it further. In the mean time the Atlantic is to us a practically permanent ocean, varying only in its tides, its currents, and its winds, which science has already reduced to definite laws, so that we can use if we can not regulate them. It is ours to take advantage of this precious time of quietude, and to extend the blessings of science and of our Christian civilization from shore to shore until there shall be no more sea, not in the sense of that final drying-up of Old Ocean to which some physicists look forward, but in the higher sense of its ceasing to be the emblem of unrest and disturbance and the cause of isolation.

I must now close this address with a short statement of the general objects which I have had in view in directing your attention to the geological development of the Atlantic. We can not, I think, consider the topics to which I have referred without perceiving that the history of ocean and continent is an example of progressive design, quite as much as that of living beings. Nor can we fail to see that, while in some important directions we have penetrated the great secret of Nature in reference to the general plan and structure of the earth and its waters and the changes through which they have passed, we have still very much to learn, and perhaps quite as much to unlearn, and that the future holds out to us and to our successors higher, grander, and clearer conceptions than those to which we have yet attained. The vastness and the might of Ocean, and the manner in which it cherishes the feeblest and most fragile beings, alike speak to us of Him who holds it in the hollow of his hand, and gave to it of old its boundaries and its laws; but its teaching ascends to a higher tone when we consider its origin and history, and the manner in which it has been made to build up continents and mountain-chains, and at the same time to nourish and sustain the teeming life of sea and land.

THE NEW REQUISITIONS FOR ADMISSION AT HARVARD COLLEGE.*

By Professor JOSIAH PARSONS COOKE.

AT the close of the last academical year the Faculty of Harvard College published a new scheme of requisition for admission, which will be followed at the admission examination of 1887, and thereafter. This scheme has been very slowly matured. It was originally prepared by a large committee of the college faculty, and was discussed in all its details for more than three years, first by the faculty, afterward by the corporation and the Board of Overseers, and finally was adopted by all the governing boards of the college. The scheme is complex, and any one desiring to understand all its possibilities must study the details in the pamphlet in which it has been announced. It is sufficient for the present purpose to say that, while it permits and even encourages the old line of linguistic studies on which students have hitherto been prepared for all the New England colleges nominally with nearly the same requisitions, the new plan opens other avenues of admission; and, among these, one to which we desire especially to call attention, as it demands and invites a thorough preparation in mathematics and physical science, with only that minimum of linguistic training which is universally regarded as an essential prerequisite of liberal culture.

In the new scheme students will be admitted to Harvard College as candidates for the B. A. degree who can write correctly a short English composition, and thus show that they are acquainted with a few prescribed classical English works; who can read at sight simple Latin, German, and French prose; who have a general knowledge of the history of the United States and of England; who have mastered the elementary mathematics, including analytic geometry and the rudiments of mechanics; and, lastly, who have had a certain amount of laboratory practice in physical science, including both physics and chemistry.

Of the several alternatives which the new scheme offers, the one above described will probably be chosen by most students who are seeking a scientific rather than a literary education. But this general plan of preparatory studies may be varied in details to meet different circumstances: thus, an advanced course in Latin or French may be offered in place of the German; but this substitution is not generally advisable, for the study of German, if deferred, must be taken up in college (the ability to read ordinary German as well as French prose

* Descriptive List of Experiments on the Fundamental Principles of Chemistry. By Josiah Parsons Cooke. (For the use of Teachers preparing Students for the Admission Examination in Chemistry at Harvard College.)

being an essential requisite for the A. B. degree), and this linguistic power is more easily acquired in early youth than afterward, when the mind is engrossed with severer studies.

This broadening of the requisites for admission is the last step in a series of changes by which, at Harvard College, scientific culture has been placed on the same footing as literary culture, and recognized as an equally fitting preparation for the degrees in arts. Those who have advocated these changes have seen clearly from the first that the study of natural science could not compete with the study of literature as a means of culture unless the discipline were equally severe, and unless legitimate scientific methods were strictly followed. To master a scientific subject as a body of systematized truth, and present it elegantly at a written examination, is a literary work, and the ability to do this work well is a normal result of literary training. The nature of the subject-matter does not essentially alter the character of the mental effort, and the power of ready acquisition and clear expression works very much in the same way, whether the material fashioned be science, history, or literature. This literary power is a talent of the very highest order, in many professions the one power needed, and in all professions a power of great value. But it is not the scientific power. It is not the power by which the physician investigates disease, by which the navigator crosses the ocean, or the geologist explores a continent; it is not the power by which a large part of the practical work of modern civilization is accomplished. The true test of scientific power is the ability to interpret Nature, and this can only be acquired by cultivating to the utmost—1. The perceptive faculty, by which observations are made; 2. The delicate manipulation required in experimenting; and, 3. The inductive method of reasoning by which correct conclusions are drawn from the results of observation or experiment. Moreover, long experience has shown that the old literary methods of education, so far from tending to cultivate the scientific faculties, rather tend to blunt them, and therefore that, without unusual native talent, the best results of scientific training can not be attained unless we begin with pupils at an early age. It is easy to awaken among college students a taste for natural science, and all the easier on account of the barrenness of their previous studies; but, so long as the average college student is not taught to use his perceptive faculties until that late stage of his education, it is obvious that the standard of scientific culture in our higher institutions of learning can not compare with that of the literary culture which has engrossed the attention of the student from childhood. We can not reach a standard that will command general respect until we can secure real science training in the preparatory schools. The acquisition of scientific knowledge by the study of text-books, however excellent in themselves, will not in the least degree promote this end, unless possibly by awakening a desire to study Nature. What we require is, that the eye should be trained to observe, the hand to experiment, and the judgment to reason. Hence it is that, in the new scheme of requisitions for admission to Harvard College, the requisition in chemistry has been stated thus: "A course of at least sixty experiments in 'general chemistry,' actually performed at school by the pupil. . . . The candidate will be required to pass both a written and a laboratory examination. The written examination will be directed to testing the candidate's knowledge of experiments and experimenting, as well as his knowledge of the principles and results of the respective sciences. The laboratory examination will be directed to testing his skill in experimenting. At the hour of the written examination the candidate will be required to hand in the original note-book in which he recorded the steps and results of the experiments which he performed at school, and this note-book must bear the indorsement of his teacher, certifying that the notes are a true record of the pupil's work." The requisition in physics is stated in similar language.

The pamphlet, whose title is given at the head of this notice, was prepared chiefly for the purpose of accurately defining the requisition above stated. It presents certain novel features.

In the first place, the course here presented is limited to the fundamental principles of chemistry, and no attempt is made to develop the scheme of the chemical elements. At Cambridge this scheme is fully illustrated in a subsequent course, which is the natural sequel of the one we are here discussing. Such a limitation of the subject-matter has a very great advantage in an elementary course, by enabling the teacher to fix attention on the general principles of the science, selecting for illustrations only those facts which have a general interest, and avoiding the great mass of details which usually so greatly encumber the elementary presentation of chemistry. But, although the scope of the course is thus limited, all the fundamental principles of the science are considered, the most important of its facts are illustrated, and the general method of each of its great departments is explained.

In the second place, demonstrations by the teacher are systematically used in this pamphlet to supplement the experiments made by the students, and a complete outline is given of a systematic course of instruction in the elements of chemical science which is logically followed out from beginning to end. The ground is taken that it is not necessary, in order to secure the full advantages of the experimental method, that each student should perform every experiment for himself. If this is attempted, a course in chemistry must be made very meager, since, on account of either their danger or their expense, a large number of the most instructive experiments must be omitted; but these can be shown once for all, without danger and with comparatively slight cost, on the lecture-table. If the student has actually performed in the laboratory a sufficient number of experiments to give him the spirit of the method, he will usually comprehend the full significance of others which are plainly exhibited before him.

In the third place, quantitative as well as qualitative experiments are introduced from the first, and all the usual measurements of chemistry are illustrated. Examples are given of the determination of melting and boiling points, the student first constructing the thermometer with which the determinations are made. He further learns how to measure with the calorimeter the amount of heat evolved in chemical processes, and to find the specific heat of the materials used. There are also simple examples of quantitative analysis and of the determination of molecular and atomic weights ; and, lastly, easy methods of determining gas and vapor densities place even those measurements within the reach of elementary students.

In the fourth place, great pains have been taken to reduce the expense of the course to the lowest possible point. To this end common household utensils such as may be made by a tinsmith, or found at any house-furnishing store, have been adapted to the purposes of instruction. The small (so-called "American") petroleum cooking-stove serves an admirable purpose for heating, its oven is an excellent drying-chamber or hot-air bath, and, with a simple attachment furnished by the makers, it may be used as a tube-furnace. So also a farina-kettle makes a good steam-bath ; and the quick-sealing fruit or milk jars are not only good gas-holders, but enable any student to perform experiments which formerly were only made with costly apparatus. The only apparatus of precision required are the scales and thermometers, which can be purchased from the dealers in chemical supplies at a very moderate cost. Indeed, the expense of the absolutely necessary outfit for a class of twenty students need not exceed one hundred dollars, and twice this sum will purchase everything that could possibly be needed for the course here laid out.

Lastly, the course has been made inductive throughout. It is a wise economy in education to seek from each study that discipline which it best affords. The memory is a greatly abused faculty. The necessities of language, the commonplaces of history, and the requirements of literature and art, task even the most retentive memory, and it is a waste of resources to overburden it with a mass of scientific details which, even if retained, will be of little value except to the specialist. Chemistry is peculiarly an inductive science, and to teach it deductively is to use it for a discipline, which is much better furnished by mathematics or mechanics ; yet chemistry is taught deductively whenever, as in most elementary text-books, the chief stress is laid upon the symbolical expression of chemical facts and principles. To secure the peculiar discipline of chemistry, it is essential that it should be studied as it has been built up. The student must begin by observing phenomena, and be led up to the general principles through his own inferences. To begin with an abstract statement of these principles, or, what amounts to the same thing, to express from the first every phenomenon observed in symbolical language which embodies these principles, is to invert the natural order, and to abandon the inductive method. Undoubtedly, such are the precision and grasp of this system of symbols that it is of the greatest value in aiding the chemist to see relations and predict results which, without its aid, he might not have discovered at all. Nevertheless, it must be remembered that chemical symbols simply stand for the facts and theories they were devised to express, and for nothing more. They have not the generality of mathematical formulæ, and are, therefore, far inferior to such formulæ as forms of deductive reasoning. In the pamphlet before us the full meaning of chemical symbols is explained, but they are not used until the principles of the science have been developed.

An inspection of this pamphlet will show that the author, who has been for thirty years one of the most constant advocates of scientific culture in school and college, has no desire to lower the standard of university education. Except to those who have unusual mathematical and scientific talents the new scheme of preliminary studies is a decidedly more difficult way of entering college than the old classical curriculum. It has, however, a special end in view, and has been adapted to this purpose with great care, and is the result of large experience. Our colleges have always been the nurseries of scholars, of men who knew how "to clothe thought in beautiful and suggestive language, to weave argument into correct and persuasive forms, and to kindle enthusiasm by eloquence." * But we earnestly hope that while rendering as fully as ever this high service to the state by educating the men who will defend the right and repress the wrong, uphold the true and expose the false, these same schools of liberal culture will also do the equally important work of preparing earnest men "to unravel the mysteries of the universe, to probe the secrets of disease, to direct the forces of Nature, and to develop the resources of this earth." *

LIFE IN THE SOUTH-SEA ISLANDS. †

By Captain CYPRIAN BRIDGE, R. N.

THE inhabitants of the New Hebrides are Melanesians, divided into a multitude of independent and usually hostile tribes. On several islands there are communities of Polynesians, some of whom—as shown by their complexions—have preserved, among their Mela-

* The writer, in an address to the Harvard Club of Rhode Island, Newport, August 25, 1883, and published in this "Monthly" for November of the same year.

† Abridged from a paper on "Cruises in Melanesia," etc., read before the Royal Geographical Society, April 12, 1886.

nesian neighbors, their purity of descent. One of the difficulties of communicating with the natives is due to the immense variety of languages, which renders it impossible to obtain the services of an interpreter likely to be of use in more than a single district. This difficulty has seriously impeded the work of the missionaries of the Presbyterian Church who labor in the islands from Ambrym southward, and of the Anglican Melanesian Mission, who have taken spiritual charge of the northern islands, the Banks group, and the Solomons. The necessity of confronting this difficulty has been advantageous to linguistic science, for the Rev. Dr. Codrington, of the Anglican Mission, has recently published a learned work on "The Languages of Melanesia." As a rule, white men and natives communicate with each other by means of a very singular jargon, like the "pigeon English" of China, known as "sandal-wood English," or the "*bêche de mer* lingo," designations which explain its origin. Bearing in mind who the devisers of this dialect were, it is not surprising that a prominent characteristic should be the frequent interpolation into a sentence of exceptionally vigorous profanity. This the native linguist utters without a suspicion of its being improper. A few phrases, without the ingredient just mentioned, will convey an idea of what the jargon is. "That fellow man he no good" = "That is a bad man." "That fellow woman Mary belong a me" = "That woman is my wife." "Big fellow yam he stop Tanna" = "Large yams grow in Tanna." This "pigeon" is the universal mode of communication between white men, except missionaries, and islanders throughout the southwestern Pacific, and is used by both Englishmen and foreigners. I have even heard the oath administered to Melanesian witnesses in a French court of justice at Noumea in the following terms: "Me talkee true, me no tell lie, me no gammon; me," raising the right hand to the sky, "swear." At many places even this imperfect method of conversing is unknown; but so intelligent and such adepts in gesture-language are the natives that they understand and make themselves understood by a stranger much more thoroughly than the inexperienced would expect.

At the time of my visit there were, including the wives and children of the missionaries, between eighty and a hundred white residents in the group. There are probably now fully a hundred in all. Aneiteum is completely Christian, and the natives are among the most devout of believers. A more attentive congregation than that attending the church at Port Inyang it would be impossible to meet with. The members carry with them to worship small libraries of devotional works, which require bags and baskets for their conveyance. On other islands progress has been made—progress with which the missionaries themselves are dissatisfied, but which appears very surprising to a stranger, who can discern the difficulties of the situation. As a rule, a missionary establishment consists of the clergyman and his wife, and perhaps children, and one or two teachers, or subordinate lay missionaries, who are generally natives of other and remote islands. A plain wooden house is brought from New Zealand and put up for the missionary and his family, usually with his own hands and those of his brethren, who assemble for the purpose. A church, built in the style of the native houses—of reeds and mats—occasionally at the older stations of coral masonry, and a similar edifice for a school, with the comfortable huts of the teachers and the catechumens, complete the buildings of the station.

The other white men in the group follow the occupations of planters and traders. Attempts, in one case on a large scale, were made some years ago to grow cotton, but without much success, on the Island of Sandwich or Vaté. The cultivation of maize and coffee has been tried with better results on the same island. The staple vegetable product is *copra*, the dried pulp of the cocoanut.

The trader is usually the agent of a mercantile firm, which supplies him with a certain quantity of "trade" goods, and receives in return his copra. He has, as a rule, three or four laborers in his employment. Owing to a singular custom or prejudice, these are rarely natives of the island in which they work. He buys the nuts from his neighbors, and, with the assistance of his laborers, prepares the copra. On the more savage islands, arms and ammunition, as long as their introduction was allowed (and it is doubtful if it has yet been quite stopped), matches, pipes, and tobacco are the things commonly given for nuts. The price varies greatly, according to locality and year; but a pipe, a small fragment of tobacco, or a box of matches is frequently given for a dozen nuts. Every few months a small vessel visits the different stations, bringing goods and supplies of food for the traders and taking away the copra, which, on arrival in Europe, is converted into oil, the refuse being used in the manufacture of cake for cattle.

The New Hebrides natives differ greatly in physical qualities. On Mallicolo there are two distinct races, distinguished by the length and breadth of their skulls. Persons familiar with the group can readily point out an Espiritu-Santo man, a Sandwich man, a Pentecost man, or a Tanna man. The dress differs in nearly every island, and in some is very remarkable, more so on Tanna, on Erromango, on Api, and on Ambrym than would bear public description. The modes of dressing the hair are various. On Tanna it is dyed auburn or nearly gold color with lime, and is gathered into small thin locks which are wound round with a slender filament like thread. On Sandwich the women shave the skull completely. On Espiritu-Santo they shave it, but leave a broad ridge of frizzled hair in the middle from poll to forehead, like the well-known garniture of the head of a clown. I had the good fortune to witness some Santo ladies making their toilet, which was effected by mutual assistance. The person being dressed had her head shaved with a knife of bamboo, of course without soap or any facilitating lather.

In the New Hebrides the villages are always invisible from the water. Each village as a rule consists of a set of different hamlets or collections of huts. The houses in the various islands differ greatly in architecture, but I always found them beautifully neat and clean. The dead are usually buried at the door of the hut. On Ambrym and some other islands the young unmarried men in a village always sleep in a large house specially set apart for them.

In general it may be said that all the Melanesians who have not been converted to Christianity are cannibals. It is not, however, to be supposed that human flesh is their ordinary diet. It is probable that none partake of it often, and that large numbers have only rare opportunities of doing so. They are almost invariably ashamed of cannibalism, and will generally conceal their indulgence in it or discontinue it if a white man comes to live among them.

Wars are nearly perpetual, and the non-Christian natives invariably go armed. I have been among natives whose custom it was not to lay aside their weapons even to eat, but keeping them in their right hand to take their food in the left. The spear, the bow and arrow, the club, and the tomahawk are all in use in the New Hebrides, but there are many fire-arms in the hands of the natives. The Tanna men have a high reputation for boldness, and even in ordinary intercourse they have a more independent bearing than most of their neighbors. Native wars are not usually very sanguinary; at least, pitched battles are few. The savage art of war consists in murdering stragglers and making forays to kill women and children, burn down villages, and lay waste plantations.

Nothing struck me more than the great intelligence of the natives of Oceania in general and of the Melanesians in particular. Within the limited sphere of their acquirements whatever they do they do thoroughly.

The Melanesians of the Solomon Islands are less known than their neighbors of the New Hebrides. The climate of the group is less favorable to white men.

The Solomon-Islanders are in general an aquatic people. Their canoes, except as New Ireland and New Britain are approached, have no outriggers. They are of graceful shape, of large size, built up of pieces, and with seams "payed" with a sort of vegetable pitch. The villages are usually near the water's edge and unconcealed by trees. The use of fire-arms is still not very common. But on some islands, notably Guadalcanar, they are expert bowmen. The Savo men make clubs covered with straw plaiting of singularly fine texture and tasteful pattern. Some of the spears are of prodigious length, and are tipped at the end with a human bone cut into a multitude of sharp and brittle points, which break off in a wound and are said to certainly cause death. Having succeeded with some difficulty in purchasing one of these at Tesemboko, a friendly native cautioned me against allowing any one to touch a point even with the finger, saying that, if any person did, "My word! he die quick."

New Britain is one of the most beautiful countries in the world. The contours of the lofty mountains are very graceful, and the variety of tints of the rich tropical verdure is as attractive as it is unusual. The dense foliage is interspersed with patches of grass of an emerald hue. At Matupì in Blanche Bay there is an active volcano, a curious volcanic island, and a region of hot springs. I traveled by land once from Nodup to Blanche Bay, and the heat and fatigue were more than compensated by the beauty and varied character of the scenery traversed. The New Britain people go entirely naked. They are not a fine race, and want the activity and vigor of the Solomon-Islanders. Foreigners have introduced a good many fire-arms among the inhabitants of Blanche Bay and Kambeirah, but as a rule the spear, usually adorned with brightly colored feathers, is their weapon. They build good houses and make excellent nets and ingenious fishing-baskets. They are the only cannibals I know who are not ashamed of their fondness for human flesh. A German settler told me that overtures were made to him to arrange the purchase of the body of a man who had been accidentally killed by a neighboring tribe with whom the would-be buyers were not friendly. The reason given was a desire to eat what otherwise might be wasted in a commonplace interment.

The curious and little understood ceremonies of the *duk-duk* are extensively performed in New Britain and the neighboring Duke of York group. One thing about them is certain, and that is, that those who are initiated into the mysteries obtain considerable influence over the rest of their tribesmen. There is another very remarkable custom, about which I was given information by the Rev. Mr. Rooney of the Wesleyan Mission, which labors in this part of Melanesia. It may be described as follows: If A injures B, B burns down C's hut, or makes a hole in his canoe, or sticks a spear in the pathway so that C is nearly sure to run against it. B lets C know that he has injured him, and the reason of it; when C is expected to settle the account with A, the first aggressor. On the whole, the New Britain people are the least attractive of all Melanesians whom I know. They are very dirty, and do not possess the skill in fashioning pottery, or carving wooden bowls, of their neighbors in the Solomons and the Admiralty Islands. Yet among them I had some very worthy friends. One of them I specially remarked from having been struck with the persistence with which he insisted on the observance of the curious Melanesian etiquette, that a person should never be asked his name. The savage has no objection to his name being known, but politeness requires that it should be asked of some one else. The New Britons have a curious money called *dawarra*, made of small shells perforated and strung on fibers of some plant. It is counted by measure of length, and has some of the properties of the money of civilization, as it owes its value to the rarity of its material, and it can be easily divided into small sums.

The Ellice, the Gilbert (or, as they are usually called by the seamen, the Kingsmill), and the Marshall groups, are all composed of low, flat islands formed of coral. Some of them are nearly perfect *atolls*, Maraki in the northern Gilberts being perhaps the most perfect in the world.

It seems absurd to speak of the fertility of soil apparently composed almost entirely of sand, nevertheless even among these coral archipelagoes there are differences. The Marshall Islands have the most profuse natural growth of ferns and grasses; on the Gilbert Islands there is not even a fern; while the Ellice Islands hold an intermediate place between the sterility of the latter and the comparative fertility of the former. It is customary to reproach the natives of Oceania with invincible indolence; and, if it be a fault, I fear they must be convicted of desultoriness and unsteadiness in their work. The amount done in a year would if spread over the whole period give, I believe, a very respectable daily average. The labor expended by the Ellice-Islanders in cultivating their lands and growing the huge *taro*, which is the staple of their diet, must have been enormous. The vegetable is planted in vast trenches which look as though they had belonged to some great fortress long ago fallen into ruin. Even with the best implements the excavations would be extremely laborious, but one is lost in astonishment when one finds that many of the taro-beds now in existence were excavated by generations in possession only of tools of shell or wood.

All the islanders are expert fishermen. Shark's fin being an article of export, the shark is eagerly sought for. He is often caught without a hook; a piece of bait is put on the end of a line passed through a noose in a larger line and towed from a canoe. As the shark is seen to follow the bait, it is gradually hauled up till his head and shoulders are past the noose. The latter is then quickly tightened. Another plan, of which I was told on good authority, is even more remarkable. The sharks are supposed to sleep in rather shoal water under projecting pieces of coral with their heads just protruding. When a Gilbert-Islander sees one in this position he dives down with a small stick in his hand and gives the fish a tap on the nose, repeating it until the shark, for comfort's sake, changes his position and leaves his tail where his head had been. This is the fisherman's chance, and a second dive with a noose at the end of a line soon makes him master of his game. I am bound to say that I never saw this mode of fishing.

The Ellice-Islanders are all Christians, having been converted by the missionaries of the London Mission Society. They are inoffensive folk and have no arms. The Nukulailai people declare that they never did have any; but the natives of other islands undoubtedly had some until comparatively recently. They are well educated, can all read, and are most persistent letter-writers. No present is more acceptable to them than a few sheets of paper and some pens.

Some of the islands of the group were nearly depopulated twenty years ago by Peruvian kidnappers, who carried off many natives to work in Peru. As a general rule the population of each island is very small—never, as far as I am aware, exceeding a few hundreds. All are governed by a constitutional sovereign and a *kaupuli*, or parliament. The form of government, in its present state, is to a great extent the work of the missionaries. At Vaitupu I noticed in the *kaupuli* house some curious couches, carved out of single pieces of wood, with four legs and a solid block like a pillow at one end. To my inquiries it was replied that as some members of the assembly are fond of long speeches, the debates are occasionally protracted, and wearied legislators get rather sleepy, so the couches are provided to enable them to slumber in comfort. All the natives wear European clothes of some sort. The men usually put on at least a shirt; the women's dress is peculiar. They wear a long garment of colored calico, tight round the neck, and reaching in ungirt looseness to the heels. On their heads they put a curious high-crowned hat, cross-laced with bright ribbons, exactly resembling the head-gear of a brigand in the opera of "Fra Diavolo." Ladies of a certain age in the Archipelago are inclined to *embonpoint;* and a crowd of portly dames streaming out of church in their flowing calicoes and brigand hats, always many sizes too small for them, is a sight not soon to be forgotten.

The Gilbert-Islanders are only partially Christianized. The southern portion of the group is under the London Mission; some of the other islands are under American missionaries, who, however, do not reside in them. Like the Ellice Islands, these also were once governed by kings; but in all the southern part regal government has been abolished, and a sort of federal republic has been established in several islands. The natives seem to have an innate capacity for parliamentary institutions. I have been present at several debates among them, some of which were so far of importance that on their issue depended whether we should be at peace or at war with the inhabitants. Nothing could exceed the regularity and decorum of the proceedings, and some of the speakers were assuredly fluent, and apparently eloquent. The islanders are capital sailors, fearlessly visiting distant islands in canoes of large size, not dug out of single trees but built up of pieces. One very remarkable feature of the islands is their dense population. This is especially striking, as the islands are extremely barren.

The weapons of the Gilbert-Islanders are curious wooden swords and halberts, studded with shark's teeth. They make also complete suits of armor out of cocoanut-fiber, stiff hauberks, cuisses of matting, and close-fitting helmets, like those of the Crusaders. Fire-arms have of late to a great extent replaced the old weapons, and the armor has been generally laid aside. It is odd that the custom of the duel should be common among the Gilbert natives. Duels are rarely to the death, but a wooden sword bristling with shark's teeth can, to judge from the tremendous scars on many of the men's bodies, inflict very severe wounds.

The Marshall Islands are less known than the Ellice or Gilbert groups. The Archipelago is divided into two chains; the Ralick, or western, and the Radack, or eastern. The Marshall Island men are tall, the women singularly short. Some of the latter sex, who are of high birth, are very good-looking, and extremely graceful. The men are tattooed on the body and right up to the temples. Those of chiefly family cover the whole body; commoners leave an unmarked patch from the armpit nearly to the waist. The lobe of the ear is perforated, and often greatly distended with an unclosed hoop of wood. When this ornament is not carried, the vacant loop of flesh is hung over the point of the ear. The women tattoo the back of the hand and the forearm nearly to the elbow in tasteful patterns, so that they appear to have on open-worked silk mitts. The male costume is decidedly picturesque. It consists of two enormous tassels of shreds of *vau* bark joined by a plaited strap and disposed round the body so as to form a kilt. It is kept in place by a cord covered with plaiting of pretty pattern, which cord, being often over a hundred feet long, is wound round the waist till it forms a large coil. Chiefs particularly affect great length of cord, which does not improve the wearer's appearance, as it makes the kilt too bunchy. With a coil of moderate size the kilt is very becoming, and recalls the Albanian *fustanella*. The women's dress is composed of two mats worked with devices of great taste. The so-called "Greek key" is common as an ornament at the edges. These mats are bound round with a cord, similar to that of the men, above the hips, leaving a few inches of mat above, while the rest reaches nearly to the ankle. The costume is thus very like a low-necked European gown without sleeves, and, though a little stiff for sitting down in, has an attractive appearance when the wearer stands.

The Marshall Island canoes are like those of the Gilbert Islands; but they are larger, and on the sloping platforms built out on each side there are frequently little houses in which three or four of the crew can sleep. The natives are great navigators. They actually make curious charts of thin strips of wood tied together with fibers. Some of these charts indicate the position of the different islands with a surprising approach to accuracy. Others give the directions of the prevailing winds and currents. These are used as instruments to determine the course to be steered, so as to take advantage of the wind and to allow for current-drift rather than as charts are used by us.

The low atolls of the three groups just spoken of are called by sailors the "Line Islands," from their position with respect to the equator. In spite of their general unproductiveness, the number of cocoanut-trees is so large that there is a considerable export of copra. One English and three German firms have nearly the whole business in their hands. There is one American firm also, but its transactions must be much less extensive than those of the English, and of at least two of the German houses. All are represented by resident traders. At Majuro Messrs. Henderson and MacFarlane have a very complete and extensive head-station. At Jaluit the German firms of Hernsheim and Company, and the South Sea Company, the latter at the time of my visit under the style of Capelle and Company, have large head-stations for this part of Oceania.

The contrast between Kusaie and Ponapi in the Carolines and the low atolls of the Marshall, Gilbert, and Ellice groups, is striking and agreeable. Both of the former are called by our sailors "high islands," a designation which is soon appreciated by any one who has cruised among the groups mentioned. Kusaie is densely wooded and picturesque. Its soil is very fertile. The people, who only amount to between three and four hundred, are all Christians, having been converted by the American missionaries, who have an important station on the island. The American missionaries are fond of giving to the petty chiefs of the tribes with whom they come in contact the absurd title of king. Tokusa, the chief of Kusaie, which name includes all the islets near as well as the main island of Ualan, is accordingly called king, though his subjects are so few. He speaks English well, and is very intelligent and well-mannered. The natives are straight-haired and rather light-colored. They paint their canoes a dull red, with a pigment made of an ochreous earth found in two caves on Ualan. Their houses are large, with high-pitched roofs and elevated gables. Most of them now wear some article of European dress, but the garb of the country is a broad sash woven of the fiber of an inedible banana, frequently dyed black except at the ends, where there are some bright colored bars, which make it resemble the silk scarfs of the Roman peasantry.

On the little Island of Lelé, on which the natives live, there are some interesting ruins, which appear to be those of a fortress with Cyclopean walls of large irregular blocks of basalt, twenty-five to thirty feet thick. There are also canals and artificial harbors. The natives can give no account of them, though King Tokusa told me that he believed they had been constructed by his ancestors. In the splendid Island of Ponapi, the inhabitants of which are more barbarous than those of Kusaie, there are even more remarkable ruins. Four-sided platforms stand out of the water, and are composed of layers of hexagonal basaltic prisms, like those of the Giant's Causeway, transversely superimposed one on another, the prisms of a layer being at right angles to those of the one above or below it. These platforms are arranged to form canal streets, and the walls of edifices erected on them are built of basaltic columns in like manner. The ruins are much overgrown with the rich vegetation of the tropics, but enough is visible to disclose the remains of a city, of a second Venice, of whose builders we are ignorant.

Yap, in the Western Carolines, is singularly interesting. The natives are good-looking and profusely tattooed. The hands and forearms of the women are tattooed with mitts as in the Marshall Islands. The houses are large and built of mats. They stand on an extensive platform of earth revetted with stones, against which is placed the curious stone money of the islanders. This is in the form of huge disks of arragonite, quarried in the Pelew Islands, more than two hundred miles away. The disks are like great grindstones, and frequently weigh three tons. People have said on hearing of this money that there was not much risk of its being stolen. Nevertheless, an American trader at Yap complained to me that some which had been placed in his charge had been carried off in the night.

I visited two other islands which may be included in the Caroline group. These were Nuguor and Greenwich Island, both low atolls. At Nuguor human sacrifices are still offered; one had occurred about two years before I was there. The inhabitants are of almost gigantic size. They are ruled by two queens, and have retained the tradition of their migration from Samoa and the name of the chief, Vavé, who led it. Greenwich Island is very little known. The Pelew-Islanders are a particularly interesting people. In each village there are large "club-houses," to which the younger men resort. A few women from neighboring villages also frequent them. It is not considered *comme il faut* for a woman to enter one in her own village. If she did she would become an outcast; going into one a mile or two off, however, in no way affects her position. The buildings are of wood, and the gable-ends are adorned with carvings and frescoes. There is also in the Pelew Islands a curious kind of money. It is really bits of antique glass vessels and jasper beads, which the people believe came down from the gods, but which in fact came out of the ships of early navigators.

In the Polynesian archipelagoes of Samoa and Tonga we find a superior race and, especially in the latter, a comparatively advanced civilization. The people of the two are akin. The Samoans are of a softer type than the Tongans, who live in a cooler climate. The beauty of the Samoan women has often been remarked, and it would be difficult to exaggerate it. The Tongans are of greater stature, and the women are rather handsome than pretty. The scenery of the Samoan Islands is only surpassed by that of New Britain and Eastern New Guinea. Except in the Vavau group, the Tongan scenery is at best rather poor, as the islands are, in general, low. Samoa is always hot, while the winter climate of Tonga-tàbu is delicious. Both archipelagoes are visited by hurricanes, but they are apparently less violent than those of the West Indies and come rarely.

Tonga is trying a constitutional experiment on its own account. Mr. Baker, an ex-Wesleyan missionary, has drawn up a constitution to which the venerable King George, who was over ninety years old at the time of my visit, but was as vigorous as most men of sixty, has given his approval. There is a cabinet of which the ex-missionary is the head, a parliament, and a constitutional sovereign. There is also a regular judicial establishment. Great Britain has entered into treaty relations with Tonga, and has even accorded a limited jurisdiction over British subjects to Tongan courts. Englishmen in the South Seas are fond of laughing at the Tongan polity. But it is to the credit of the new state that its public expenditure is small, that it has been for years perfectly orderly, and that there are in the group probably five times as many miles of carriage-road as there are in our colony of Feejee. There are many Tongans still living who saw the first horse brought to their own particular island, and thought that it was a large kind of pig. There are hundreds of horses in the archipelago now, and most Tongans are fearless horsemen. They are also capital cricketers, which they owe to the good sense of that very able man, the Rev. Mr. Moulton, who is, or was till lately, at the head of the Wesleyan Mission. Mr. Moulton has founded an admirable college. The scholars receive an education equal to that given in the colonies. I was present at one of the public examinations, and among other surprises heard the first canto of the "Paradise Lost" recited in the native tongue. Most of the Tongans are Wesleyans, but there is also a Roman Catholic mission in the country, and a moderate number of the natives belong to that church.

All Pacific-Islanders, even many of the Melanesian cannibals, are distinguished by a remarkable refinement of external manners. The Polynesians excel all others; and, probably, no people in the world surpass the Tongans and Samoans in grace and dignity of deportment. The latter races are highly ceremonious, and great observers of etiquette. In Tonga at a *kava* party, where an infusion of the root of the *Piper methysticum* is drunk, the order of precedence is as strictly observed as it would be at a European state banquet. In Samoa the *kava* root is chewed by young ladies before being placed in the bowl. In Tonga it is invariably pounded on a lap-stone. Connoisseurs assert that the beverage is never so good as when the root has been chewed. I never quite got over my repugnance to that method of preparing it, and only drank of it sparingly and to avoid giving offense when out of Tonga. Even in Tonga I felt little inclination to indulge in it freely, possibly because I retain my youthful dislike to rhubarb and magnesia, the flavor of which that of *kava* closely resembles.

To one who has cruised much among the small islands of the Pacific, and who has grown familiar with the monotonous landscapes of

Australia, the scenery of New Guinea appears especially grand and imposing. It differs greatly in character.

The natives of the coast evidently belong to two distinct races. From a point rather to the westward of Port Moresby right on to Aroma, the people are light-colored, of tall and graceful figure, grave in manner, taciturn, and abhorring cannibalism. The men's dress is simply a strip of bark twisted into a string. The wearers of this express great contempt for neighboring tribes who go perfectly naked. The other race is black, of shorter and sturdier figure, nimble, cheerful, loquacious, and cannibal. The men wear a curious and decent costume of leaf. The women of both races wear the *titi* petticoat of grass, which is very like a ballet-dancer's skirt. At Port Moresby the houses are built half in the water. At Tupu-selei, Kailè, and Kappa-kappa, they stand out in the sea at a distance of a couple of hundred yards from the beach. Throughout the parts of New Guinea with which I am acquainted, the inhabitants are ingenious and industrious agriculturists, and carefully fence in their plantations. Their houses are large and well built. They make very fine fishing-nets. The canoes of Port Moresby are of enormous size, and the trees out of which they are dug are procured by barter from tribes living a long way off. The Port Moresby pottery is made in large quantities for export; as is a finer kind at Toulon Island by the dark race. This shows that both races engage in manufacturing industry for the express purpose of trading with the products, a thing of happy augury for their future progress.

My second trip to New Guinea included visits to the Louisiades, to Woodlark Island, to Rook and Long Islands, and to the mainland near Cape King William. The Louisiade people are in physique and knowledge of the arts inferior to both races of Southeastern New Guinea. Many of them are quite unfamiliar with white men. But I found, even among them, some who had heard of Queen Victoria, a name which is so frequently known and so greatly respected throughout the Southwestern Pacific that the stranger is fairly astonished. A native of Joannet Island intimated that he was aware that Queen Victoria was the chief of Cooktown, the little port in Northern Queensland. On Rossel Island I noticed, in the case of some of the men, the curious dentition which the eminent Russian traveler, Dr. Miklukho Maclay, has called "macrodontism." A continuous tooth extends over the space usually occupied by two or three teeth. The Woodlark-Islanders are very fierce, and at one time I thought a collision with them inevitable. They make the same curious gesture of salutation as the Basilaki (or Moresby) islanders, pinching first the nose with one hand and then the navel with the other, finishing up with a low bow.

The natives of the northeast coast of New Guinea whom I met were black, and not superior in physique to the Louisiade people.

While in the south of New Guinea the natives are in the stone age, these people have not got beyond the period of shell implements. They could hardly be made to understand the use of a tomahawk, and were frightened by striking a match.

The Rook-Islanders seemed never to have seen a white man. Smoke coming out of the mouth of an officer with a pipe greatly surprised them. A chief on being brought up to a looking-glass was struck dumb. The exhibition of a cat caused great excitement, which was immensely increased by showing them a sheep. They are a light-colored, tall, good-looking race, who express great repugnance to cannibalism. They build good houses and temples, have well laid-out villages, and possess large highly painted canoes ornamented with carvings. They practice circumcision, and an incised figure of an alligator adorns the entrance to their temples. Their reception of my companions and myself was courteous and friendly in the extreme. One of the officers of her Majesty's ship Dart was a good conjurer, and the delight with which the disappearance of a coin through the bottom of a tumbler was hailed by the natives was intense.

A few observations on the condition of the Southwestern Pacific may not be out of place. I believe that the members of even the most savage tribes desire to be on friendly terms with white men. There are some tribes who, in pursuance of the barbarous custom of taking heads, will make unprovoked attacks on white visitors. But they are comparatively rare exceptions. I fear that most of the so-called "outrages" are to the natives what the retaliatory action of ships of war is to us. We regard the latter as the proper punishment of an offending tribe; and the islanders look upon the killing of a white man—if any white man has done them an injury—as much the same thing. Events have proved that the old practice—for years given up by us, but still followed by some European nations—of the wholesale punishment of the people of an island charged with an "outrage" does nothing to improve relations with the islanders. The plan of punishing only the really guilty has been far more successful, and when that is universally adopted the friendliness of our relations is sure to increase.

The diminution of population is one of the mysteries of the Pacific. It has perhaps been arrested in Feejee. Time will show if the stoppage is permanent. On the small Wallis Island under the Catholic, and Niué, or Savage Island, under the Protestant missionaries, the people increase; elsewhere, whether Christian or savage, they diminish. It is common for natives to speak of the greater numbers of their tribes in former days, and there is evidence to support their assertion. Can it be that the islands of the Pacific have been the seats of a succession of races, all of which have at a certain period in their history declined and disappeared, and that our acquaintance with the present inhabitants only began when the declining stage had been reached? The suggestion is made with timidity, but I confess that I sometimes fancy that something like it may explain the existence of the curious ruins so widely scattered throughout Oceania.

The Pacific islands can not be mentioned without calling to mind the missionaries who labor among them. Their success has been very great; but, great as it is, I think its magnitude has been exaggerated. The Christianity of the Western Polynesians is not much to boast of; and their present state of civilization is much more owing to frequent intercourse with white men who are not missionaries than is generally admitted. Without missions they would not have advanced so far as they have done; nor with them would the advance have been what it is had no other white men ever gone among them. The same thing is true of Feejee. Some of the "pioneer" missionaries are men of whom every country might feel proud. The influence for good of such men as Mr. Moulton, of Tonga, or Mr. Robertson, of Erromanga, is enormous; but they are men of enlarged views and of even statesman-like capacity, who would be powerful over their fellows anywhere. The same may be said of Messrs. Lawes and Chalmers in New Guinea, and will explain to a great extent their astonishing success. Mr. Chalmers is a born leader of men, and his ascendency over those with whom he is brought in contact is due to a never-failing tact and a nobility of mind which have been rarely equaled.

It is hazardous to forecast the future, but it does not seem that the Pacific islands are likely, for generations yet to come, to be of use to mankind at large. Fertile as they may be, they can only be made productive with labor, of which no man can say where it is to be obtained.

SOME OUTLINES FROM THE HISTORY OF EDUCATION.

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[*Concluded.*]

THE institution at Dessau made distinct approaches to object-teaching. It remained for Pestalozzi, however, to give this method philosophical expression and justification. We know how the Pestalozzian idea has been enlarged and improved by Froebel and his followers. Our present purpose is to trace this idea in its beginning and development under Pestalozzi.

The reformer was born January 12, 1746, at Zürich. His first attempts to serve the people were of a literary character, and this as member of the staff of a political newspaper published for the improvement of the masses. He then entered the ministry and made an attempt to preach. After a pastorate even shorter than those of modern times he applied himself to the study of law. Over-work compelled him to seek rest in the country. Here he soon entertained the purpose of becoming a farmer, because he believed that in this way he could best work for the culture of the farmers. The aim of his life seems justly set forth in these words : "To bring about a better destiny for the poor in the country, by a firm establishment and simplification of their means of education and instruction." His agricultural undertaking at Neuhof was a failure from the beginning. Meanwhile he opened an orphan asylum, and undertook the care of fifty parentless children. The time came when there was neither bread nor wood. Then eighteen years of waiting—of worse than waiting, of reproach and increasing self-distrust, verging close upon despair. In 1780 Pestalozzi published "The Evening Hours of a Hermit," setting forth his educational doctrine in most suggestive phrase. A year later came "Lienhard and Gertrude"—a book for the people. This was written in a few weeks, and, as Pestalozzi says, "without my knowing how I came to it. I felt its worth, but only as a man in a dream feels the value of a blessing. I saw the degradation of the people, and 'Lienhard and Gertrude' was a sigh over this degradation." It was fundamental with Pestalozzi that the education of the child should commence, as it were, at the first instant of life. "By the cradle must we begin to wrest from the hands of blind Nature the guidance of our race, that we may place it in the hands of that better power which has taught us by the experience of centuries to reflect upon the nature of her eternal laws."

During the winter of 1793–'94 Fichte gave lectures or discussions in Lavater's house. Pestalozzi was led by these interviews to write his second great work, entitled "Inquiries concerning the Course of Nature in the Development of the Race." Events soon called the reformer from writing to practical work. War, with its orphans, came into the valleys of Switzerland. An orphan asylum was opened near Stanz. Pestalozzi, already fifty-one years of age, took charge of this asylum. Very touching are his words : "I had gone to the most secret clefts of the mountains to find my work, and truly I found it. But think of my condition ! I, alone—deprived of all appliances for education—I alone overseer, keeper of accounts, house-servant, in an unfinished house, among evils of all kinds. The children numbered about eighty, all of different ages, some in open beggary, all entirely ignorant. I stood in their midst. I repeated sounds to them, made them give the sounds after me. All who saw it were astonished at the result. It was really the pulse-beat of the art which I sought. I did not know what I was doing. I knew upon what I had resolved—death, or the accomplishment of my purpose."

Pestalozzi found a more permanent resting-place at Yverdun. The institution which was established here continued from 1805 to 1825, and became most widely celebrated. "In 1809 the school contained fifteen teachers and one hundred and sixty-five students from Germany, France, Italy, Switzerland, Russia, and North America." Here, as elsewhere, jealousy did its deadly work. The teachers quarreled for Pestalozzi's favor. In 1816 twelve teachers left the institution, and there was no help against the disorder. On the 17th of February, 1827, Pestalozzi died, these being his last words: "I forgive my enemies. May they now find peace! I go to eternal peace."

In outlining Pestalozzi's thought, I note the following points as perhaps best expressing his method: Education must be determined by the nature of that which is educated. Man is a law unto himself. What he is dictates the mode in which he shall be trained. Man's powers are not the result of accident—they are his own interior, original possessions. They came with him. Education, therefore, which does not base itself upon a right understanding of these integral human powers, and of the nature which they express, is not education—has no right to the name or the claim. Pestalozzi, by stating this truth, and by forcing it, as it were, into the world's consciousness, deserves lasting praise. Here is the first step toward a scientific treatment of education; it is not, in itself, such treatment, does not even prove such treatment possible—it is the point of beginning, the corrective, the safeguard. This truth is fundamental in Pestalozzi's thought. It found expression in "The Evening Hours of a Hermit," and is repeated in every subsequent writing. "Universal upbuilding of the inner powers of human nature is the universal aim of culture." Pestalozzi's system, therefore, when self-consistent, rests upon his interpretation of human nature. Our reformer believed man to have a threefold being. He was body, mind, and conscience. It is a vital part of Pestalozzi's thought that man's welfare depends upon a good and truth-obeying heart. Here is place for the religious element, and we find Pestalozzi speaking as follows: "Belief in God is the source of peace, peace is the source of inward order; inward order the source of undisturbed application of our powers, and this order becomes, in turn, the source of their growth and development to wisdom. Wisdom is the source of all blessing." We have thus far two essential factors in Pestalozzi's thought: education is determined by the nature of the educated—man is threefold, body, mind, and heart. Proceeding a step further we inquire, What precisely is it that this threefold being requires? Do body, mind, and conscience unite in demanding for their education a single method? Pestalozzi answers yes, and affirms that the common, universal law, is *development*. To-day we theoretically recognize this law, and admit its vital import in all educational endeavor; practically we too often ignore it, and proceed after the old and evil fashion of preparing the mind for market as the animal is prepared for sale. There was a time in the slowness of history when this very principle of development was unknown, a time when education was confounded with fact-knowledge. Pestalozzi found an illustration in the tree. Who can educate a crab-apple tree into a peach-tree? A crab-apple tree can be made a better crab-apple tree perchance, a peach-tree can be made a better peach-tree by development, by assisting the natural processes, by warding off destructive forces. Development must take place by assimilation of food. This is true for body, mind, and spirit. Around about man lies his food. Nature furnishes material for man's education. That is his development. Pestalozzi saw this, and he saw no less plainly that the material might hinder the development. Improperly given food will destroy life. There must, then, be a law for this development process; assimilation must proceed properly, or all will fail. *The subject-matter of education must receive its law from the course of the development process.* How does man unfold his powers? What is the order given here by man himself? Pestalozzi's answer brings us face to face with the essential characteristic of his method. Man unfolds his powers by beginning with sense-perception, with "Anschauung." This German term is nearly as untranslatable as the word "Gemüthlichkeit." Sense-perception covers perhaps the larger portion of the meaning, yet does not include it all. Anschauung signifies that clear discernment of an object which is given by direct face-to-face acquaintance. Man's development begins exactly here with such perception. This is the basis of all knowledge. The degree of intensity, the clearness, the comprehensiveness, the order of this perception, must be decisive respecting each individual's education. Pestalozzi says, "When I look back and ask myself what I have really accomplished for education, I find I have settled it that the fundamental principle of instruction lies in the recognition of perception as the absolute basis of all knowledge." This principle originates and philosophically justifies object-teaching. Perception has a law or method; standing at the bottom of education, perception leads naturally up in orderly gradation to that which is higher. Perception must be reduced by definite and psychologically arranged exercises to a perception science. When giving instruction, we must see to it that the objects are examined by the child one at a time, and not in the dim distance, but close at hand. We must see to it further that characteristic illustrations are brought forward, not any abnormal representations. From the perception of a thing arises its name, from the name we advance to an enumeration of its properties; from this we finally develop the definition, the clear idea. Here is the philosophy of object-teaching. Let the child see. This seeing must be something far greater than any general vision; it must be a seeing arranged according to a strict psychology. Pestalozzi worked out a system of object-teaching, or a psychology of perception. We have place for but the briefest statement: "The entire sum of all the external properties of an object is found within the object's circumference and in the relation of its number, and is made known by speech." Therefore the art of perception must start from this threefold basis—number, form, and speech. We must teach each object to the children as unity, separated from all with which it may seem to be bound. We must then teach them to observe the form of every object, that is, its measure and relations; lastly, we must make them acquainted with the entire circle of the words and names for the objects which they know. It would be of little service to follow Pestalozzi further in this direction. The arrangement of natural phenomena under form, word, and number, contains the fatal error of incomplete classification. There can be no question that form and number are modes of things, but this is a seriously inadequate account of Nature's manifestations. The supreme fact which the world teaches, and which thrusts itself upon us every hour of every day, is the fact of causative energy. Nature's great truth is cause and effect. Pestalozzi took little or no account of this, and consequently dealt with the form and number of objects, to an exclusion of the objects themselves. Pestalozzi had no place for chemistry, or physics, or physiology. Here lies the absurdity of object-teaching as often presented. He who fails to see Nature *at work* misses the organizing principle of her manifestations, and can not teach according to Nature. The principle of object-teaching was fundamental with Pestalozzi. As concerns this distinguishing feature of his thought, we would say that, because perception is the first step in the unfolding consciousness of a child, it does not follow that perception should be made *supremely prominent* in the education of the child. Were the child to remain a child, we should have regard solely to those things which might exercise his childish faculties. Since the child is to pass from childhood to manhood, it is well to have care lest over-development of the child-method tend to perpetuate a childish habit of mind.

Pestalozzi distinctly admits that the *idea*, not the vision, is the distinguishing mark of human reason. He repeatedly says that the child must be brought on to a full possession of the general notion, the concept. If, then, we make object-teaching, or the gaining of distinct sense-impressions, the *exclusive* work in all early training, we stand in danger of prolonging this childish state, and of failing to furnish the mind with clear, independent ideas. Directly, or indirectly, the movement now under consideration is responsible for one of the greatest evils of our time. I name this the pictorial disease. *Everything* must be depicted.

Literature, forgetting that grown men and women ought to be able to think, treats them as children, and illustrates. It has come to pass that we can not read a strong article or a strong book. Everything is diluted with pictures. Let me not be misunderstood. True art is the painter's poem—the hero's deed. True art is no illustration, no picture, no copy of Nature. It is Nature herself, as she has taken up her abode in the artist's mind and heart. Here is one who will paint you grass so that you shall think it *is* grass, and go to put your hand upon it. Here is one who will paint you no grass, but bring a green field with soft breezes playing over it, sweet odors rising from it, life dwelling in it; and this one is the artist. His language is no illustration, no picture, but something far higher, even an actual creation. The fundamental command of Pestalozzi, proceed vision-wise, is susceptible of exaggeration. Too literally obeyed, this command is harmful in all departments of human activity. This thought has wide application. It lies against all *exclusively* physical training, all training depending solely upon material objects. There is great danger lest such training keep the student from clearness of vision in *the eye of the mind.* He sees things, but, unless things lead to independent thoughts, they are nothing more than pictures upon the retina of flesh. Our thought is applicable to classical education, in so far as words become the objects and are studied as mere things. Latin and Greek, taught as *vital* parts of language, are, even in their minutest particles, so many expressions of the mysterious and indestructible power of thought. Pestalozzi's teaching that the clear idea is *the result* to be secured by education is unquestionably true. Man proceeds from sense-perception to concept when he proceeds normally. The end, however, is often lost sight of in the means; the idea is not realized because the object, the matter, the substance, is too prominent, too permanent, too overbearing.

The writer hopes that not the least result of this historical survey has been to set forth Pestalozzi's fundamental principle as a controlling power in the educational development of the past. Man not only should give law to his education, he has done so. The education of China was the Chinese interpretation of man; the education of India was the Indian interpretation of man; the education of Greece the Grecian interpretation of man; and the new education of to-day is our interpretation of man. Has man's nature been taken at its entirety by any educational scheme of the past? Is man's nature taken at its entirety by the educational system which to-day claims precedence and finality?

We have seen man, the grown man, as a child: this was and is China. We have seen man as member of a caste, belonging body, soul, and estate to his order: this was and is India. We have seen man a Grecian or a Roman, self-conscious as a Grecian or Roman, not self-conscious as man. We have seen man a contra-natural member of a contra-natural church: this was the monk type of the perfect man. We have seen man, not satisfied with such interpretation of his nature, go back to Greece and Rome, finding in Demosthenes and Cicero the ideal being. To-day we see man as the producer, the builder, the one who brings things to pass.

In these "outlines" very much of importance has been omitted. This concluding paper does not make place for the things that were neglected. The very recent appearance, and for the first time in English, of "Histories of Education," offers excellent opportunity for that detailed and thoughtful consideration of our subject which its importance demands.

We pass to a brief consideration of Mr. Spencer's work on "Education, Physical, Intellectual, and Moral." This title gives plain recognition of the fact that education is threefold because man is threefold. Mr. Spencer's treatise originally appeared in four review articles, as follows: 1. "What Knowledge is of most Worth?" 2. "Intellectual Education." 3. "Moral Education." 4. "Physical Education." It may be allowable to preface our remarks upon Mr. Spencer's teaching in these papers with some expression as to its value. We would vote to-day for compulsory legislation which should see to it that every parent and instructor and rational person read Mr. Spencer's articles on education, and then read them over again, and then studied them, and then practiced such portions of their teachings as we accept. Without doubt, the bearing of this last clause is all too apparent; but, as it is needed for the fair expression of our conviction, it shall remain unaltered.

Mr. Spencer has discovered that pigs, sheep, and horses are better taken care of than children. There is more and better science applied to the physical well-being of pigs than to that of our own race and kindred. Mr. Spencer states the desideratum in physical education as follows: "To conform the regimen of the nursery and school to the established truths of modern science."

"Without calling in question the great importance of horse-training and pig-feeding, we would suggest that, as the rearing of well-grown men and women is also of some moment, the conclusions indicated by theory and indorsed by practice ought to be acted on in the last case as in the first."

I quote at this point one of those paragraphs which would secure a vote for the compulsory legislation before mentioned: "There is a current theory, vaguely entertained, if not put into definite formula, that the sensations are to be disregarded. They do not exist for our guidance but to mislead us, seems to be the prevalent belief reduced to its naked form. It is a grave error. We are more beneficently constituted. It is not obedience to the sensations, but disobedience to them, which is the habitual course of bodily evils. Perhaps nothing will so much hasten the time when body and mind will both be adequately cared for as a diffusion of the belief that preservation of health is a duty. Few seem conscious that there is such a thing as physical morality. Men's habitual words and acts imply the idea that they are at liberty to treat their bodies as they please. The fact is, that all breaches of the laws of health are physical sins. When this is seen, then, and perhaps not till then, will the physical training of the young receive all the attention it deserves." In his paper on "Intellectual

Education," Mr. Spencer presents a series of contrasts between past and present education. From an extreme in physical education followed an extreme in mental education—we are now learning the value of being good animals. Learning by rote or memory is passing away. Learning by rules is disappearing. From this has resulted the postponement of once earlier studies to a later time. This also is decidedly by way of contrast. We have reached object-teaching or culture through observation. Again, we present truths in the concrete, not in the abstract. The seventh and last contrast is shown by the desire we manifest to make all acquirement of knowledge pleasurable. Mr. Spencer calls attention to the common characteristic of these contrasts, viz., an increasing conformity to the methods of Nature. This leads to Pestalozzi's teaching that education must adapt itself to the natural process of mental evolution. After these special considerations, Mr. Spencer announces certain principles which may serve as guides in the matter of intellectual education until the establishment of a rational psychology. "Proceed from the simple to the complex. Begin in the concrete and *end* in the abstract. Education must accord, both in mode and arrangement, with the education of mankind considered historically. Education should proceed from the empirical to the rational. Self-development should be encouraged to the fullest extent. The method of instruction should create pleasurable excitement."

Education is to provide for man as a threefold being. The *intellect* must work upon *all* the material offered for development, must convert this material into organized knowledge. We now reach a subject that has been thought by almost *all* educators to present the question of questions, viz., What subject-matter is best adapted to unfold the complex nature of man? While I regard the high importance thus attached to this question as entirely beside the mark and a serious hindrance, I know that the matter can not be ignored. On all hands people seem constrained to reform education by determining *what* shall be taught. Let us note, for a moment, the forms of intellectual activity engaged in the acquisition of organized knowledge. These may be phrased as discrimination, detection of identity, and reproduction, both direct and creative. For the natural, proper action of these powers, *the material is a matter of comparative indifference.* I can analyze, synthesize, and remember, whether I deal with Latin, Greek, mathematics, chemistry, literature, or strictly speculative philosophy. That department which presents the largest number of facts, *best classified*, will offer most opportunity for the action of the intellect. In all effort to educate, therefore, we should present that branch or those branches only which contain the most facts in the best order.

There was a time when it might have been fairly said that *the classical languages alone* met the necessity just indicated. After middle-age scholasticism had worn out the patience of men, and before scientific discovery pointed to better things, there was naturally and necessarily a return to ancient Greece and Rome. The direction thus given to education could not but bring it to pass that the facts of the Greek and Latin languages should be both the most numerous and the best classified of any facts in the possession of men. The study of Greek and Latin was a way of deliverance from scholasticism, and as such was best calculated to educate the entire man. We see the historical and rational ground for that supremacy which was enjoyed by the classical languages in all educational undertakings. This supremacy, resting on most facts best classified, would necessarily give way before any other subject-matter presenting an equal or greater number of facts as well or better classified. Now, it is a claim unqualifiedly put forth by those able to judge, that the physical sciences offer more facts under better classification than do Latin, Greek, psychology, ethics, history, or any other non-material study. This is a simple question of fact, if, indeed, it be a question at all. Allowing the claim, we shall conclude that the physical sciences have full right to take their places by the side of the classical languages *so far as promoting the activities of the intellect is concerned.* This disposes of the question of discipline. To analyze, synthesize, and remember, is to organize knowledge. When full opportunity is given for such mental operations the requirements of mental discipline are realized. Education, however, is something more than mental discipline. Education is the development of man's complex nature. When we discuss the question of material, therefore, we must discuss it in the light of man's nature. The question as to the *relative value of knowledges* Mr. Spencer considers in his first article, and he does so, be it carefully observed, from a different education-idea. He says, "To prepare us for *complete living* is the function which education has to discharge." I would amend this, and say, to prepare us for complete *being*, complete *becoming*, is the function which education has to discharge. Here is not a distinction without a difference. Had Mr. Spencer's language stood isolated from the rest of his article, it would have been possible to find in his words, "complete living," what is contained in the words "complete being." Connected, however, with Mr. Spencer's classification of human activities, with the principle on which this classification is based, and with the whole tenor of his article, the "complete living" presents, as it is intended to present, the practical, physical idea. Man is viewed as the producer, the one who brings things to pass, the one who adjusts himself to his environment. I remember all that Mr. Spencer has said about yielding to no one in his estimation of æsthetical development, but I also remember these words: "As the fine arts occupy the leisure part of life, so should they occupy the leisure part of education"; and these words: "Here we see most distinctly the vice of our educational system; it neglects the plant for the flower," which may be true, and the supreme value of the flower remain unimpaired. Mr. Spencer believes that man's nature should be unfolded for the sake of making him a complete liver—we believe that man's nature should be unfolded *for its own sake*, for what there is in it of power for goodness, for what he, the man, can become by loving reality and by serving his fellow-beings. These ideas are essentially different; as much so as the *culture*-idea of humanism and the useful idea of philanthropism. It should be understood, however, that we are not restating, in slightly different language, this culture-idea which humanism advocates. The word culture labors under the misfortune of being either too indefinite or too narrow. It means nothing, or it stands for general æsthetical development. The cultured man is thought of more from the side of mind and taste than from the side of moral excellence. The true education-idea embraces the development of the *entire* man, and any system which aims at else than this or less than this is defective in theory, and will be defective in practice. Let us interpret Mr. Spencer's language, not in itself alone, but in its connections, and as related to the entire course of his argument. "How to live—that is the essential question for us; not, how to live in the mere material sense only, but in the widest sense. The general problem, which comprehends every special problem, is, the right ruling of conduct in all directions, under all circumstances: in what way to treat the body, in what way to treat the mind, in what way to manage our affairs, in what way to bring up a family, in what way to behave as a citizen, in what way to utilize all those sources of happiness which Nature supplies; how to use all our faculties to the greatest advantage of ourselves and others; how to live completely; and this, being the great thing needful for us to learn, is, by consequence, the great thing which education has to teach." By the aid of this fundamental position Mr. Spencer sets forth the kind of material which he believes best qualified to educate man. "Our first step is to classify, *in the order of their importance* [italics the writer's], the leading kinds of activity which constitute human life." Mr. Spencer gives the following classification: I. Those activities which directly minister to self-preservation. II. Those activities which, by securing the necessaries of life, indirectly minister to self-preservation. III. Those activities which have for their end the rearing and discipline of offspring. IV. Those activities which are involved in the maintenance of proper social and political relations. V. Those miscellaneous activities which make up the leisure part of life, devoted to the gratification of the tastes and the feelings." This classification, so far as it is to be made the basis of educational endeavor, I can not but regard as fundamentally defective. *It proceeds from a confusion of primary necessity with primary value.* Mr. Spencer, in commending his classification, says, "The actions and precautions by which, from moment to moment we secure personal safety, must clearly take precedence of all others." Admitted, on a proper interpretation of this word *precedence.*

I must know that poison, in certain quantities, will destroy me. Is this knowledge, *therefore*, more valuable than other knowledge?

"The power of self-maintenance necessarily preceding the power of maintaining offspring, it follows that knowledge needful for self-maintenance has stronger claims than knowledge needful for family welfare, is second *in value* to none save knowledge needful for immediate self-preservation." Because I must know how to secure bread and potatoes, nay, more, because I must actually secure them, before I can support a family, is this bread and potato knowledge therefore *in any sense* more valuable than that knowledge of moral requirements which might help to make me a good father, a proper guide, and loving companion to those who should look to me for protection? Mr. Spencer further says: "Those various forms of pleasurable occupation which fill up the leisure left by graver occupations—the enjoyments of music, poetry, painting—manifestly imply a pre-existing society. And consequently that part of human conduct which constitutes good citizenship is of more moment than that which goes out in accomplishments or exercise of the tastes; and, in education, preparation for the one *must rank before* preparation for the other." What do these words "rank before" mean? Before in *necessity?* Yes. Before in value? No. Because we must be civilized before we can develop our æsthetical, our moral and religious nature, *therefore* civilization is more valuable than the flower of spirituality? The rose must have its roots and body, must have them well trained and cared for; *therefore* the roots and body are more valuable than the opened bud with its wealth of color and fragrance. Let us hold clearly in mind Mr. Spencer's teaching as to the proper subordination of material in education. First should come that education which prepares for direct self-preservation; second, that which prepares for indirect self-preservation; third, that which prepares for parenthood; fourth, that which prepares for citizenship; fifth, that which prepares for the miscellaneous requirements of life. How shall this order be applied? "Of course, the ideal of education is complete preparation in *all* these divisions; but, failing that, the aim should be to maintain *a due proportion* between the degrees of preparation in each. And what is due proportion? It is an attention *greatest where the value is greatest, less where the value is less, least where the value is least.*" Take this language in connection with the following sentence: "For the average man, we say, the desideratum is a training that approaches nearest to perfection in *the things which most subserve complete living*, and falls more and more below perfection in the things that have more and more remote bearing on *complete living.*" Here we draw near Mr. Spencer's meaning in the words "complete living." Complete living is more to be sought in self-preservation than in the creation of a poem, the production of harmonies, the luxury of benevolence. Man, Mr. Spencer himself being judge, is a threefold being, having body, mind and spirit. Why should we, in educating him, take least thought for the flower? Why should we take less thought for the flower than for the roots? Because without the roots there can be no flower? But so also *with* the roots it may chance that there shall be no flower. There is many a splendid body with soul so small that Omniscience scarce could find it. If we look *primarily* to the roots, think constantly of the roots, make the roots uppermost in all endeavor, we shall develop roots and nothing else. Existence is, indeed, a struggle. Shall we not, then, educate men for their immediate task? Most certainly. Shall we forget, or put at all into the background, the fact that men have a spiritual nature, and that in this lies their highest and fullest measure of being? This, to some, may savor of cant and of the seminaries. Let it, however, be settled, apart from sects or creeds, whether there are such excellences as *sincerity*, purity, truthfulness, self-forgetfulness in the desire to be and to do good. Let it also be settled in what relation these stand to the other excellences of man's nature. Let it be seen whether they are not supreme in the sense of *making up his worth*, in the sense, that is, of giving value to all his other attainments, physical and intellectual. These important matters being settled in the affirmative, as very many would settle them even in our so-called materialistic age, education would at least proceed in a *different spirit.* While it would not be the business of education to make men and women good, it would be impossible to call those educated who had never so much as thought on goodness, or never considered themselves in the light of their highest possibilities and duties.

With respect to the subject-matter of education Mr. Spencer offers this delicious bit of satire: "Men who would blush if caught saying Iphigēnia instead of Iphigenīa show not the slightest shame in confessing that they do not know where the Eustachian tubes are located, what are the actions of the spinal cord, what is the normal rate of pulsation, or how the lungs are inflated." This sentence may be turned about and made to utter truth as follows: Men who would blush in not knowing where the Eustachian tubes are located, what are the actions of the spinal cord, what is the normal rate of pulsation, or how the lungs are inflated, show not the slightest shame, not the very slightest shame, in confessing that they do not know when Plato lived or what he thought, when Goethe lived or what he thought, when Angelo lived or what he wrought. The entire duty of man is not to locate the Eustachian tubes. The entire duty of man is not to know the actions of the spinal cord, or how the lungs are inflated—not one particle more than it is his entire duty to say Iphigenīa. It is not *what* a man knows, but *how* he knows what he knows, that determines the character of his education. This thought, in the writer's opinion, is fundamental. To lead up to it and to give it full emphasis has been the special object of all remarks here made upon Mr. Spencer's teaching concerning the relative value of knowledges. It was not expected that any argument with regard to his position in this matter would have weight for those who, of necessity, that is constitutionally, accept his opinions. As was shown in the contrasts between humanism and philanthropism, the antagonism rests upon a sharply defined natural dualism. Man is a creature of opposites. It is perfectly competent to say to him *be good;* it is also perfectly competent to say to him be good *for something.* Argument may not hope to obliterate this distinction. The "Andover Review," June, 1886, contains three notable articles bearing on the present phase of our subject. These are: "The Group System of College Studies in the Johns Hopkins University," by President Gilman; "The Harvard New Education," by Professor Howison; and "Individualism in Education," by Dr. Denison. President Gilman shows that Johns Hopkins has, from the first, recognized the thorough-going distinction between a college and a university. "The idea that university education should be based upon collegiate training is generally admitted—except in the United States. This distinction the authorities in Baltimore have endeavored to emphasize. From the beginning, the plans included collegiate instruction for those who were not ready for graduate work." In attempting to provide college courses the old difficulty of the "curriculum" was encountered. Johns Hopkins met this difficulty by an intermediate course. Several parallel schemes were arranged which were of equal length and assumed to be equally difficult. They led to the same degree. They were spoken of as equally honorable." It is surprisingly interesting to note the studies found in *all* these courses. They are "logic, ethics, and psychology; physical geography and history; English, French, and German; a laboratory course, for at least one year; and also physical culture, vocal culture, and drawing." That the Johns Hopkins University should require of *all* its undergraduate students such studies as logic, psychology, and ethics, must seem a trying thing to many of the younger materialists. That these subjects should be given preference over Latin and Greek as furnishing a culture *required* for *all* undergraduates can not but seem incredible to thousands of classical instructors. President Gilman, expressing his own opinion of the plan, says: "I am far from thinking that the group system here devised is perfect, even for our requirements. It is constantly studied and frequent efforts are made to improve it. But, as far as I know, the instructors in this university are unanimous in thinking that it is the only method practicable for us to adopt. We should doubtless differ very much from one another in our estimate of the different courses, and *we should be likely to counsel young men differently as to their selection.*" This sentence suggests the question whether the entire scheme is not more largely the result of compromise than of mutual conviction and agreement. That a large body of instructors should agree upon such prescribed studies as above set down, for *all* undergraduate students, will not find ready credence. The movement at Harvard which is now phrased as the new education, though an extreme, is perfectly natural, and easily lends itself to such brilliant advocacy as that of Professor Palmer : "The old conception had been that there were certain matters, a knowledge of which constituted a liberal education. Compared with the possession of these, the temper of the receiving mind was a secondary affair. Under the new conditions college faculties were forced to recognize personal aptitudes. In assessing the worth of studies, attention was thus withdrawn from their subject-matter, and transferred to the response they called forth in the apprehender. Hence arose a new ideal of education in which temper of mind had pre-eminence over *quæsita*, the guidance of the powers of knowing over the store of matters known." Nothing could well be found more admirable than the reply of Professor Howison to this paragraph. So far as a recognition of the needs of human nature is concerned, he seems to meet the case completely : "Study can not be liberalizing unless it is pursued in a temper of freely dutiful diligence, but no more can it be so if it does not put its subject in possession *of the constitutive fibers of civilization* [italics present writer's]. Our life in humanism is linked by vital threads to the growth of the past as well as to the environment of the present—threads that can not be severed except on penalty of spiritual death." We inquire how shall the student be put in possession of the "constitutive fibers in the historic substance of civilization"? In reply, Professor Howison gives *his* curriculum for all undergraduate study :

"Languages, classical and modern ; mathematics, in all its general conceptions, thoroughly apprehended ; physics, acquired in a similar manner, and the other natural sciences, though with much less of detail ; history and politics ; literature, especially of the mother-tongue, but indispensably the masterpieces in other languages, particularly the classic ; philosophy, in the thorough elements of psychology, logic, metaphysics, and ethics, each historically treated, and economics, in the history of elementary principles, must all enter into any education that can claim to be liberal."

This is, indeed, a "liberal" course of study, but no amount of argument could persuade a large number of our educators, or of our average citizens, to *insist* upon such a course for *each student*. If here alone be a liberal education, many would say, so much the worse for a liberal education ; we will have none of it. To compel a boy, who has absolutely no natural disposition for it, to spend his years in groans over mathematics or classics, or psychology, logic, metaphysics, and ethics, would be a matter calling for action from the Society for Prevention of Cruelty. And yet the writer is in direct sympathy with the position of Professor Howison. The writer believes that these are the constitutive fibers of civilization, and would have them wrought into every young man or woman who might seek an education. Nevertheless—and this is the point of all our urging—*true reform in education can not be found on this path.* Agreement as to the subject-matter of study is an impossibility. All judgment on this point roots itself in the constitution of the individual, and, while many may agree that the topics named above compass the circle of being, they will not agree as to the desirability, much less the *necessity*, of demanding years of toil in such topics from each young man and woman. Professor Howison believes that "thoughtful and competent judges—outside of the Harvard circle—will stand by the plainly reasonable conviction that there is a sum of knowledge touched with sentiment, and invigorated by masterly grasp, the lack of which demonstrates the lack of a truly cultivated mind." This is most admirable. But who are the thoughtful and competent judges? And, when they have been found, who shall assure us that their curriculum will be that of Professor Howison? From the nature of human nature there can not be such agreement. *Individuality* is as much a constitutive fact of each human being as is the trait which he shows in common with his fellows. This individuality, representing his inheritance, his childhood, his training by environment, *will* assert itself. And this means nothing more or less than that he, the given person, will go out toward certain subjects and withdraw from others. Force him to study Latin and Greek, or mathematics and physics, even through the college course, and you may do him irreparable harm. At all events, there is here an open question. The writer believes it will remain an open question until the time of the perfect psychology. Meanwhile the course of education can be advanced, and that on another line. *This is the line of better teaching.* One of the most important truths contained in Mr. Spencer's treatise is found, as I think, in the following paragraph: "A branch of knowledge which, as commonly taught, is dry and even repulsive, may, *by following the method of Nature,* be made extremely interesting and profoundly beneficial. We say profoundly beneficial, because the effects are not confined to the gaining of facts, but often revolutionize the whole state of mind." A more pregnant sentence with regard to education can not be found. To follow the method of Nature in teaching a given subject means to recognize the *special* character of the subject itself, and at the same time to discern its *natural place in the unfolding being of the pupil.* The first secures the organic presentation of the subject *per se,* the second finds in the pupil a natural—i. e., a constitutive—response to the matter as developed. The business of teaching is to *establish relations,* not to communicate facts; these relations are between the being of the pupil and subject studied. That there are, for *all* subjects, such relations, that these relations are, *in all cases,* natural, must be the guiding conviction with every teacher. Instead, then, of attempting to reform education by "devising courses," by finding out new things, by contesting the supremacy of this or that branch of knowledge, does it not seem wiser to insist upon *right teaching?* Subjects as doleful to the common student-mind as Latin grammar, Greek grammar, formal logic, psychology, and ethics, have been made "to revolutionize" the whole state of being for many a pupil, and this by right teaching. All knowledge is worthy—worthy the best of human endeavor, both to secure and to communicate. Let us, then, pass from this as from a matter not needful longer to be discussed, and demand *true teaching.*

THE PHYSIOLOGY OF ATTENTION AND VOLITION.

By JAMES CAPPIE, M. D.

"GIVE me a fulcrum," cried the ancient sage—"give me a fulcrum, and I shall move the world." "Grant me a few postulates," says the modern reasoner, "and I shall read you the riddle of the universe." An unchallengeable postulate, however, is almost as difficult to find as a stable extra-terrestrial fulcrum. The scientific "spirit of the age" walks by sight and not by faith. It revels in facts. It numbers, and weighs, and measures; it catalogues and describes; it compares and classifies. To make progress among the secrets of Nature its highway is experiment, and its watchword is demonstration. For any interpretation of a natural phenomenon it demands proofs that can appeal to the senses, and it looks with wholesome suspicion, if not contempt, on mere "arm-chair" speculation.

The marvelous success in advancing knowledge, and in gaining power over the forces of Nature that has resulted from its use, is convincing evidence that the scientific method of interrogation is sound, and that it should always be adopted wherever possible. But it is not always possible to apply the method. The nearer we approach the region of subjective phenomena, the more difficult it becomes to test particular interpretations by an appeal to experiment. The galvanometer may reveal agitation in a sensory surface, but it tells nothing about sensation. The convolutions of a dog's brain may be tampered with, but he will not describe to us his feelings. Consciousness alone can discriminate the facts of consciousness; and the character, or succession, or relation of these can only be described in terms of metaphysic. Theories of physical relationship here must at first be tentative, and at the best they will require to be stated in very general terms. The argument must consist in the application of general principles; and, in choosing these, analogy balanced by common sense must be our guide. In drawing our conclusions, we may be satisfied if these can be held with some moderate degree of probability.

In attempting to gain a closer view of the somatic relations of mind, my subsequent argument will rest on the assumed correctness of three postulates. The first of these is, that every manifestation of mind is correlated to a definite mode and sphere of brain activity. This may be emphatically insisted on, whatever be the view taken as to the nature of mind itself. For, to take the illustration so frequently made use of —that of the relation of a musician to his instrument—the volume and quality and harmony of musical sounds are immediately correlated not to the fingers of the player, but to the tremors within the instrument. So the outcome of mental action, even as revealed to one's own consciousness, is not simply the result of some ideal, self-acting energy asserting itself, but it depends also on the compass and quality and adjustment of a material organization. It, of course, follows, that if we approach the subject from the physiological side, it is simply impossible to avoid the phraseology of materialism, and therefore, for doing so, I shall make no further apology.

My next postulate is, that the activity of the brain is conditioned by the activity of its circulation. The blood is to the gray matter of the convolutions what atmospheric air is to burning fuel; it is at once a necessity and a stimulus. However favorable may be the arrangement of cell and fiber, the consciousness will fail to respond to any impression, and every cerebral function will be impaired or suspended, if the circulation be lowered below a certain amount.

It follows that, so far as physiological means are to enable us to understand how mind and brain mutually act on one another, a consideration of the laws that affect the distribution of blood, and the influence of local surroundings in modifying these, must be of the first importance. Yet this is what is very seldom attended to. Volumes have been written on the relationship of mind and brain with scarcely a single reference to this aspect of the subject. While considerable progress has been made in defining the immediate sphere of activity, in certain mental acts, and especially in mapping the centers for voluntary motion, very little attention has been given to the influence which the many peculiarities of the encephalic circulation must have on the mode in which the brain may exercise its functions.

The principal general fact in regard to the local distribution of blood on which I have at present to lay stress is that, as a rule, the supply to every tissue and organ is in proportion to the demand for it. When function is quiescent, the need is slight in comparison with that of active exercise, and accordingly we find that the circulation of any organ contrasts remarkably in the two states.

Considerable difference of opinion has existed as to how this is immediately accomplished. By many writers the vaso-motor nerves seem to be regarded as veritable physiological demons, whose unsleeping vigilance foresees and provides for all local wants; and it is supposed that, while the whole motor force acting on the blood is supplied by the heart's action, these nerves so regulate the caliber of the smaller arteries that they turn on or shut off the blood-current as may seem to be necessary. While not disposed to question their great importance, a good deal might be said in favor of the notion that the molecular agitation in the tissue itself has a direct influence not only in assisting movement by lessening friction, but by exerting positive energy in urging the current onward.*

Into the controversy on these points, however, I can not enter here. For our present purpose it will be sufficient if the intimate relations between demand and supply be admitted as a matter of fact; if we can assume that functional activity involves a fuller volume and more rapid movement of blood in the capillaries of a part than does functional rest.

The last postulate I have to submit is the one on which my subsequent argument must mainly rest; but, unfortunately, it is the one whose soundness is most likely to be questioned. It is, that the mass of blood within the cranial cavity can be neither increased nor diminished directly, nor, indeed, to an appreciable extent within short periods of time.

A general statement of the argument in its support may lie in a nutshell. The available cubic space within the skull being a fixed quantity, the bulk of its contents must also continue uniform. These contents being the brain-tissue, the blood and the cerebro-spinal fluid, no one of these can be altered without an inverse change in one or both of the other contents. Thus, if a degenerative nutrition cause wasting of the brain-tissue, we must have an increase in one or both of the fluid contents, and thus evidence will be got of extreme congestion, or of serous effusion, or both. For any such change, however, time is required. Again, no amount of general depletion can reduce the intra-cranial circulation until time is afforded to allow effusion of serum to occur, because no mechanism exists for immediately raising any fluid from the spinal canal. Neither, on the other hand, can any increased force of the heart's action make the intra-cranial vessels fuller, for the cerebro-spinal fluid can not be immediately dis-

* In recent works on physiology it has been the tendency to ignore, if not altogether to deny, the active influence of local molecular change on the capillary circulation. In the higher animals, however, we have what I would consider crucial evidence in favor of its existence. I allude to the portal circulation. Here we have a large mass of blood returned from the chylopoietic viscera, which, before it can reach the heart, has to traverse the ramifications of the portal system of vessels. It will be at once admitted that considerable force must be required for the purpose. Now, if a *vis a tergo* alone be employed in moving the blood onward, the whole stress so occasioned must in this instance be borne by the mesenteric veins. The backward pressure within these vessels will be as great as what is required to transmit the blood onward to the vena cava. Is it in the least probable that the thin walls of these veins could bear such a strain? I rather think that we have here evidence that, while the general circulation may be sustained by the action of the heart, certain forces acting at the capillaries give indispensable aid in transmitting the blood through the latter.

placed. It can not be pressed into the spinal canal, for the latter cavity is already tensely full.

Referring to the classical essay of Dr. Kelly * for experimental proof of the difficulty of affecting the mass of intra-cranial blood, I content myself here with a single argument, looking at the subject from a common-sense point of view.

Whatever opinion may be held as to the nature of nervous energy, the phraseology used when its discharge is spoken of implies a certain amount of stress in the nerve-center. Thus, "vibration" can not occur without *tension*, and "explosion" implies previous *repression*. A chord will not give a clear tone when it is relaxed; and, if the chamber in which a cartridge is exploded is not perfectly rigid, the effect on the bullet is weakened. If we are at liberty to reason from analogies like these, we must infer that no nerve-center can have its energy economically liberated unless its structure is subjected to a certain amount of stress. Now, stress in a nerve-center means stress in its circulation, and this involves pressure outward and equally in every direction. If the energy is to be liberated with ease, and with exactness as to amount and direction, support to the structures immediately concerned must be as little yielding as possible. But if the cerebro-spinal fluid is at liberty to flow and ebb as readily as some writers assert, this steady support would be absent. The brain in such a case would resemble an instrument with slackened strings, and would refuse to give a clear response to impressions. Sudden or powerful or exact voluntary effort would then be simply impossible. For here, as everywhere, the discharge of pent-up energy will take place in the direction of least resistance. If the displacement of the organ's support occur more readily than the production of the intended result, such as the movement of a limb, the latter will not be successfully accomplished. Some of the energy would be wasted in the form of simple mechanical effect on the surroundings, and the result, whether mental or motor, will be less precise than would otherwise be the case.

The inference, then, is obvious. If time be an essential factor in the production of any change in the bulk of the brain-tissue, or in that of the cerebro-spinal fluid, then for the time being the mass of intra-cranial blood must also remain a stable quantity.

If we are allowed to assume the correctness of our last postulate, two corollaries require to be kept in view in applying it to encephalic physiology. In the first place, no change can take place in the circulation of one portion of the brain without that of some other part being inversely affected. In the abdomen, a determination of blood to one organ need not of necessity involve a diminished supply to the rest of the cavity, but an analogous occurrence within the skull is

* "Transactions of the Medico-Chirurgical Society of Edinburgh," vol. i.

impossible. If the anterior cerebral arteries, for example, have their supply augmented, then to an exactly corresponding extent a lessened amount can be present in the other encephalic vessels.

In the second place, no change can occur in its circulation without a change in the balance of active pressure through the brain. The stress through the whole cranial cavity must, of course, be equalized, from the amount of fluids present, but the displacement of solid particles must occur, and such displacement is not likely to be without physiological significance.

Assuming the approximate soundness of these principles, we have to consider how they may be applied in encephalic physiology. My immediate object will be to show that they must be of essential importance in any study of the correlations of mind and brain.

The first subjective condition or faculty I have to notice on its somatic side is attention. It is unnecessary to enlarge on the psychological importance of this function. It may be said to underlie every other mental faculty. It is the bringing of the consciousness to a focus in some special direction. It is required to convert sensation into that comprehensive grasp of particulars which constitutes perception ; without it, meaningless reverie will take the place of coherent thought ; nor can we conceive of any act being strictly voluntary apart from its guidance.

To study it in its physiological relation, we may for convenience take the well-known effect of attention in modifying the intensity of sensation. The mental effect produced by an impression on a sensory surface is stronger, and details about the impressing cause are more completely gathered in, when the mind is concentrated on it. On the other hand, if the consciousness is engrossed in some other direction—if absorbed by an interesting occupation or train of thought—the impression which formerly produced so much effect is felt obscurely or not at all. To account for this difference we can not be content with a merely metaphysical explanation. To say that the mind is so constituted that it can not at one and the same moment entertain with equal distinctness dissociated ideas, is only one half of the truth. There must be a cerebral correlative, and some notion as to the nature of this must be got if we are to come nearer the whole truth.

Two factors, at least, may be specified as bearing on this problem. In the first place, when the consciousness is engrossed by an immediate sensation, the sphere of encephalic activity is comparatively restricted. What that sphere may be in any particular instance it is for anatomy and experiment to determine. For receiving the impression, for quickening the consciousness, and for completing its course as a definite perception, the track involved may be wide and branching, but it does not include the whole brain.

In the second place, *the encephalic circulation will be focused in* *the direction of activity.* The molecular agitation occasions a necessity and an attraction for more blood, and determination of this takes place all the more freely on account of the quiescence of the larger part of the brain. The latter has, as it were, loosened its hold on the circulation, and the impetus toward those parts which have an attraction for it is thus all the stronger. The increased activity of the circulation then reacts on the energies of the tissue, and the mental effect produced is therefore greater.

If, now, we turn the picture, we find the lights and shadows have changed places. Let the mind be intent on solving some problem, or be engaged on some work requiring close attention and nicety of handling, and the impression which formerly so completely took possession of the consciousness may now not in the least be felt. Here, too, physiological conditions are at work. The impression fails, not simply because the consciousness is otherwise engaged, but because the track along which it is to travel is not now in a fit condition for responding to the stimulus. It is out of focus. The momentum of the circulation is now directed toward the centers of ideation and voluntary motion, and this implies a derivation from, and consequent weakening of, functional vigor in the sensory ganglia.

If the above reasoning be legitimate—even approximately so—it becomes a matter of detail to apply the principle in other directions. In speculating on any point in mental physiology, we have something more than the molecular action of the brain itself to consider. The capillary circulation, too, has its laws, and the encephalic circulation its peculiarities, and a certain balance in the latter must be maintained if cerebration is to be healthy and its outcome exact.

In perfectly normal action it is likely that the molecular changes are the dominant factor and keep the circulation under control; but not unfrequently the mass and velocity of the circulating fluid may determine the sphere as well as the character of the activity, and thus have effect on the outcome, whether muscular or mental.

If the cells of one center or class of centers be too readily explosive, they may attract the blood so strongly as to inhibit the function of other parts of the brain by the comparatively anæmic condition these are thus left in. Of this we have an illustration in the phenomena of an epileptic seizure. Here we have the blood determined in such volume to the motor centers that those which are more immediately related to consciousness have not sufficient left to enable them to sustain function with. Some writers seem to insist that during the seizure the whole brain becomes almost bloodless; but it would be as philosophical to expect a water-wheel to revolve violently by its supply of water being cut off as that the energy of the brain can be prodigally expended in defiance of ordinary physiological conditions.

On the other hand, if the attractive power of some center is under the normal, this may allow a determination to other centers to be excessive, and in this way, again, the action of the whole encephalon may be modified.

The means usually adopted to induce the hypnotic state afford us an illustration of a mode by which this condition may be brought about. In the first place, the attention is so strained in one direction that fatigue of a motor and of a sensory center has been induced. When this has happened, the molecular agitation that accompanies activity of function becomes more difficult. Repose is needed to restore its former fitness for work. The structures immediately involved are reduced to a condition approaching that of sleep, and as a result they have relaxed their hold on the circulation. The forces which sustain its balance are therefore disturbed. The condition of the encephalic circulation may now be considered analogous to that of the atmosphere with a low barometic pressure; it is mobile and disposed to storms. If attracted in one direction, it is determined strongly. Then, the very momentum with which the blood surges in that special direction reacts on and strengthens function. If it be toward an ideational center, some particular idea may so monopolize the consciousness that the judging faculty is almost as completely in abeyance as in ordinary dreaming. Thus, when something bitter is put into the mouth of a hypnotized subject, and he is told it is sweet, the notion of sweetness becomes dominant because the circulation is so strongly focused toward an ideational center that the gustatory center or track can not respond to its natural stimulus. Its function is suspended on account of the failure of a necessary condition.

In regard to volition, we need not here enlarge on the metaphysical subtilties its discussion has given rise to. We have now to do with it as a faculty subject to the tyranny of organic conditions, and our endeavor is, if possible, to catch at least a glimpse of its mechanism.

The will is essentially a prospective faculty. It must have a goal in view, whether a muscular movement, or an effort of memory, or a process of reasoning be required to reach it. Some notion must precede action, and cerebration does its work without revealing to the consciousness anything of the mechanism employed.

Certain of the factors, however, may be specified with some precision. I, of course, must assume we have to do with an educated brain, in which co-ordination has been established among its various parts.

Ideation, then, the initiatory stage of volition, involves, within a limited area, molecular movement with corresponding vascular excitement. The function of that area becomes active, and *radiation of energy must take place in some direction.* Strands for the purpose of conduction branch off in innumerable lines to other centers. What the immediate direction may be will of course depend on the circumstances of the moment and the results of previous association.

In order that the outcome may correspond with the intention, the impulse itself must be sufficient in intensity; the "points" (in railway phraseology) must be "open," the line must be clear, and the circulation must be so balanced that it is ready to surge in the required direction. The outcome may be defective by the failure of any of these conditions, and an improved adjustment in some needed respect may at once enable a correct result to be got. Thus, a familiar name or word may escape the memory, and for a time every effort may fail to recall it. Then, for example, a more successful focusing of the circulation taking place in the ideational center, the word comes up without apparent effort. From this point of view, "unconscious cerebration" means simply "better adjustment."

If the radiation be toward a motor center, we find in the latter all the conditions favorable for liberating its energy. In the waking state, in the absence of fatigue or disease, the center requires little more than *permission* to do its work. All the potential conditions for discharge are already there. With the stimulus communicated from another center, we have simultaneously molecular agitation and vascular excitement. The latter acts in two ways. In the first place, by derivation, it removes the inhibitory action of other parts of the brain; and in the second place, it further directly stimulates the molecular movement. The immediate result is turgescence or orgasm in the center itself. Then, the general law in physics, that action and reaction are equal and contrary, must here hold good. If the surroundings, therefore, be stable, natural relief will be got by the overflow or discharge of energy into a motor nerve, and contraction of a muscle will be the result. On the other hand, if the support afforded to the center be insufficient, the vascular turgescence will to some extent spend itself in displacing the surrounding tissues, and the intended movement will either not take place, or it will fail in precision and strength.

My object in the present paper has been rather to give prominence to what I consider a neglected factor in cerebral physiology than to attempt its application to all possible instances. I shall be satisfied if I have said enough to show the importance of investigation in the direction I have indicated. Indeed, when one reflects on how much research is devoted to the minute structure of the brain itself, it seems surprising that so little attention is given to what may be called intracranial physics. We have here a field which is at least as likely to be fruitful in results as the attempt to measure and classify all the varieties of nerve-cell, or to unravel the complex network of nerve-fibers.

Within the skull we have an *imperium in imperio*, where, with loyal fealty to the interests and claims of imperial unity, the rights of "home-rule" are jealously conserved. As the speck of protoplasm requires the restraint of the cell-wall to enable it to develop and exercise some specific form of energy, so the brain-mass has its form molded, and its development directed, and, especially, its energies exercised under the severe repression of membrane and bone. Then, in the approximately—if not for a time absolutely—stable mass of blood in the encephalic vessels as a whole, in the arrangement of the vessels themselves, and in the relation of their contents to the pressure of the atmosphere, we have conditions which contrast so remarkably with those we find in any other part of the body, that a consideration of their significance is surely deserving more attention from physiologists than it has yet received.—*Brain.*

HOW TO WARM OUR HOUSES.

By E. Y. ROBBINS.

IF a blizzard of unusual severity were coming from the northwest that would send the thermometer down 50° or 70° in three hours, we should expect a great increase of pneumonia and other respiratory diseases, resulting in many deaths. Now, instead of three hours, suppose the mercury were to drop threescore degrees in three *minutes*—or take another step in fancy, and suppose this great change to take place in three *seconds*—what would likely be the effect on health? And yet we bring about, artificially, changes to ourselves quite as sudden and as severe as this.

We make an artificial climate in our houses. We live in-doors in an atmosphere heated by stoves, furnaces, or steam-pipes, to 70° or 80°; and we pass from our parlor or hall so heated into the open air. At a step, literally in a breath, the temperature of the air has, for us, dropped 50° or 70°. We may put on an extra coat or shawl and shield the *outside* of the body and chest, but we can not shield the delicate linings and membranes of the air-passages, the bronchial tubes, the lung-cells. *Naked,* they receive the full force of the change—the last breath at 70°, the next at freezing or zero—and all *unprepared.* We have been sitting, perhaps for hours, in a tropical atmosphere; nay, worse, in an atmosphere deprived by hot iron surfaces of its ozone and natural refreshing and bracing qualities. Our lungs are all relaxed, debilitated, unstrung; and in this condition the cold air strikes them perhaps 60° below what they are graduated to and prepared for. Is it strange if pneumonia and bronchitis are at hand?

If we are in the West Indies, or even in Florida, and wish to come North in winter, we try to make the change gradual. But in our houses we keep up a tropical climate, or worse, for you have not the freshness of air that prevails in an open tropical atmosphere, and we step at once into an atmosphere as much colder as 40° difference of latitude will make it. It is in effect going from Cuba to Iceland—or at least to New York—at a step, and we make the journey perhaps a dozen times a day. And often, while we are still shut up in our domiciliary Cuban climate, Iceland comes down upon us from an open window. Especially is this likely to occur in school-houses, where children will instinctively seek to get a breath of fresh air that has not had all its natural refreshing qualities quite cooked out of it by hot stoves, furnaces, or steam-pipes. And all these sudden changes and shocks of cold come upon us while the whole system has its vitality and powers of resistance gauged down to the low necessities of a tropical climate.

And what should we expect as the effect upon the health—upon the respiratory organs? What are the facts? Pneumonia has increased nearly threefold in New York, in proportion to the population, within the last fifty years; and, if we had separate records for that class who most use the hot-air arrangements, we probably would find a much greater increase.

Bronchitis, which is also getting to be a very prevalent and fatal disease, has increased even more rapidly than pneumonia, and now causes about fifteen hundred deaths in New York city every year, being an increase of nearly *fivefold* to the population in fifty years. What is the cause? We have a sufficient and a very obvious cause, in the fact that in our methods of heating our houses we have been "progressing backward." Fifty years ago there were few furnaces or close stoves, and no steam-pipes, for warming; houses were warmed by open fires. The difference is radical and of great importance.

It may be briefly explained thus: Radiant heat from the sun or from an open fire passes through the air (so far as it is *pure air*) without warming it; that is to say, without being obstructed or retained by it (just as light does), and only warms the pavement, floor, walls, or other opaque body on which it falls. Hence, on a sunny day, the pavement will be at 100°, while the air above it is only 50°. The air that touches the iron bars or the surface of the fire in an open grate goes to *feed* the fire, and then is drawn up the chimney. Only pure, radiant heat is thrown into the room, not hot air; and it does not heat the air at all *directly*, but warms our bodies, the walls, furniture, etc.

Recently we have thrown this aside, and, instead, put a surface of hot iron in the room or in the cellar, in the form of stove or furnace, or steam-pipes, or hot-water pipes, against which the air *itself* is heated by convection or contact, and by its consequent lightness rises into the room and to the ceiling.

By the first method—open radiation—we warm our bodies, walls, floor, furniture; by the second we heat the *air*. By the first method all the heat the air gets it gets from floor, walls, and furniture. By the second, all the heat the floor, walls, and furniture get they get from the air, the process being exactly the reverse. The difference is radical and great.

By radiation from sun or open fire we get a quick, active heat, that travels nearly 200,000 miles in a second. By convection, or hot air from iron surfaces, we have a comparatively dead or dormant heat that moves only a few feet in the same time. By radiation from open fires the air is the coolest thing in the room ; by the air-heating method it is the hottest. By open fires the lungs get less heat than any other part of us, and so are braced and strengthened ; by the hot-air process they get more heat than any other part, because the hottest air rises uppermost about the head, and so is inhaled, making the lungs tender and sensitive to cold on our going out. Put a thermometer at the floor, and another at the ceiling, in a room heated by the hot-air process, and you will find the air at the ceiling from 15° to 45° warmer than at the floor. And so the head is surrounded by a torrid atmosphere, while the feet may be cold.

We want to warm our bodies, not the air. Cool air is denser, contains more oxygen, and warms the blood more than hot air, besides refreshing and strengthening the lungs, and bracing them against injury on going out. We want air with a normal amount of ozone. We get it with the ozone all destroyed by the hot-iron surfaces. The Professor of Chemistry in the London University (Dr. Graham, a very high authority) says ozone is destroyed at 140°.

Suppose the top of your house removed, and the sun shining freely down into it in winter. Your floor, walls, furniture, and your clothing, will have a temperature of, say, 100°, while the air itself will be only at 50° or 60°. An open fire is a miniature sun, and its radiation is governed by the same laws as that of its great prototype. With an open fire put in proper position in your room, while your walls and floor will be at about 80° or 90°, the air will be at 50°. Replace this open fire by an air-heating arrangement, and your floor and walls will be found to be only 50°, more or less, while the air rises from your close stove or your hot-air register at from 140° to 250°. If you doubt it, put a thermometer in your register, and see.

What do we want of such air as this? Evidently nothing, and so kind Nature sends it upward as quickly as possible, to get it beyond our reach ; but we defeat her beneficent intent by closing the ventilators at the ceiling ; and so after cooling somewhat it descends, still far too warm (and robbed of all its ozone, and the refreshing qualities of natural air), to enfeeble the lungs, and render them susceptible of injury on going into the external air.

The only remedy for all these mischievous conditions and effects is entirely to abandon the plan of applying the heat to the air—of making the air the carrier of heat. Heat wants no carrier, any more than light. It can outfly Mercury "and the swift-winged couriers of the air." Put your fire in proper position ; take away the iron and brick casings that inclose it and obstruct its natural movements, and, quicker than you can think, the heat will be flashed all over your room ; darting out in straight lines in every direction from the surface of the fire—down, up, and horizontally; and this without expense for pipes or hot-air ducts. If one grate is not enough, put another on the opposite side of your room. Coals are cheaper than coffins; and wood is better used to keep the body alive than to inclose it when dead.

An almost perfect arrangement for warming a room would be an open fire, and the entire surface of the walls and ceiling formed of a reflecting material. Then the least possible fire would warm us, because the heat would be kept alive, active, radiant; being reflected constantly from side to side, and up to ceiling and back, as quick as lightning-flashes; and so, impinging upon the body on all sides, would give it a lively, glowing warmth, while the air might be at almost any lower temperature. It would be like having a fire on every side of the room. Of course, this could not, in practice, be *perfectly* carried out, but it might easily be carried out approximately. Common tin plate is said to reflect eighty-eight per cent of the rays of heat that strike it. This might be stamped with some pleasant design, impressing it very slightly, to break up any distorted reflection of images. Possibly wall-paper might be made with a figured metallic reflecting surface. For a school-house this would be a great improvement, as it would reflect the *light* as well as heat from every side, and so prevent distorted positions of sitting, which are often found to prevail where the light is only on one side of the pupils.

With the heat of an open fire radiating or reflected upon our bodies, we should not want so warm an atmosphere by 20° or 30° as we do when all the heat *in the air*. And so the air would be fresh and invigorating, and the lungs would be braced up and strengthened to resist any shock from inhaling the external air. Of course, we must be *comfortable*. We must not suppose that suffering with cold is good for health. But we want just as little warmth of *air* as is consistent with comfort; and we want the heat *free* from the air, and of an active character. As long as we make our school-houses and dwellings hot-houses, or rather hot-air houses, we must expect to see our children grow up hot-air productions, liable to be withered by exposure, and blasted by pneumonia and consumption.

Some places among the high Alps have recently become famous as winter health resorts. Dr. Wise, in a book recently published in London, descriptive of some of these places, says that at Davos, a point in the Alps five thousand feet high, and surrounded by still higher snow-covered mountains, invalids can remain in the open air, even when it is 15° or 20° below the freezing-point, simply by the warmth of solar radiation and the reflection of the sun's rays from the surrounding snow-crystals. He says that the reflection of the sunbeams from the surface of the snow is so strong that ladies who carry parasols over their heads, and so preserve their complexion from the influence of the *direct* rays of the sun, nevertheless become tanned ("burnt" is the word he uses) by the reflected rays from the snow below and around them.* Altogether it is something like a great room, half a mile wide, with mountain-walls covered with snow, two or three thousand feet high, and floor of snow ; open above, with the sun's rays pouring down, and the heat being reflected from every side and from below, by a million million snow-crystals, warming the bodies of the invalids ; while the mountain-walls keep off the winds, and the quiet air is perhaps 10° or 20° below freezing.

This is Nature's sanitarium (though the picture may be a little overdrawn above the reality), and such a sanitarium, in miniature, we may have in every house, and in every school and college, if we will, by discarding our present abominable air-heating arrangements, and using, instead, open fires, in proper positions and at proper elevations for obtaining the best results (either with or without reflecting walls), and with ceilings of perforated tin plate, for the double purpose of reflection and ventilation. We want no little, inefficient, pepper-box ventilators, nor an air-supply that will send a perceptible current of cold air upon one side of us. The perforated, metallic ceiling might be stamped with appropriate artistic designs, which the light would bring out and make pleasant to the eye. In public halls this might be beautifully and appropriately carried out by an artist of good taste. In any case the reflecting surface must be made of the proper material, as some substances (a common looking-glass, for instance) reflect light from an open fire, but not the heat, well.

In a large room several grates on different sides would be required, and to obtain the best results they should be set at somewhat different altitude and in different position from the ordinary setting. Indeed, they may be made to give out double the heat they usually give. The front surface of a fire is the main efficient heating surface. Hence the grate should be made several bars higher in front than common, and if it is set higher up in the wall than usual and inclined forward at the top, it will be found to radiate downward and warm the floor much more effectually. But all these improvements in the shape, position, and setting of the grates can be easily come at by a little practice and philosophy. The main thing to be done is to quit the use of debilitating hot air, and warm the body by radiant heat, giving the lungs cool, refreshing, bracing air to breathe. It is a most important matter. Money can not measure the value that such a change in our method of warming houses and schools would be to the nation. We would be healthier and happier, and in the course of generations would have appreciably and measurably more perfect physical forms, more active brains, clearer minds, and better morals—better morals, I say, if for no other reason than that of our obeying the laws of Nature, which are the laws of God.

* See, also, an article by Professor Edward Frankland, entitled "A Great Winter Sanitarium for the American Continent," published in "The Popular Science Monthly" for July, 1885.—Editor.

THE WINGS OF BIRDS.*

By Professor W. H. FLOWER, F. R. S.,
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THE power of flying through the air is one of the principal characteristics of the class of birds. Although some members of the other great divisions of the vertebrates—the bats among mammals, the extinct pterodactyl among reptiles, the flying-fishes among pisces—possess this power in a greater or less degree, these are all exceptional forms, whereas in birds the faculty of flight is the rule, its absence the exception. Among invertebrates this power is possessed in a very complete degree by the greater number of insects.

In the normal structure of the vertebrate animals there are two pairs of limbs, anterior and posterior, never more. It often happens, however, that one pair, and sometimes both, are suppressed, being rudimentary, functionless, or entirely absent. Flight is always performed by the anterior or pectoral pair, more or less modified for the purpose. The superaddition of wings to arms, as in the pictorial representations of angels, has no counterpart in nature. The wings of the bird, the bat, the pterodactyl, and flying-fish, are the homologues of the arms of man, the fore-legs of beasts. In the flying-fish the power is gained simply by an enlargement of the pectoral fin, and the function is very imperfect; in the pterodactyl, by immense elongation of one (the outer) finger, and extension of the skin between it and the side of the body; in the bats, by elongation of the four outer fingers, and extension of a web of skin between them and the body. In the bird the flying organ is constructed mainly of epidermic structures, peculiar outgrowths from the surface, called *feathers*—modifications of the same tissue which constitutes the hair, horns, scales, or nails of other animals. Feathers are met with only in birds, and are found in all the existing members of the class, constituting the general covering of the surface of the body.

The framework to which the broad expanse formed by the feathers is attached is composed of bones, essentially resembling those of the fore-limbs of other vertebrates. The distal segment, manus, or hand, in the vast majority of birds, has three metacarpal bones and digits, the former being more or less united together in the adult state. The digits appear to correspond with the pollex, index, and medius of the typical pentadactyl manus; the second is always the longest. Both it and the pollex frequently bear small horny claws at their extremity, concealed among the feathers and functionless, but very significant in relation to the probable original condition of the avian wing. These

* Abstract of a lecture delivered at the Royal Institution of Great Britain, February 19, 1886.

claws are altogether distinct from the large, and often functional, spurs developed in many species from the edge of the metacarpal bones, resembling both in use and situation the corresponding weapons in the hind-feet. The third digit does not bear a second phalanx or claw in any existing bird.

The quills, remiges, or flight-feathers attached to the bones of the manus (called "primaries"), never exceed twelve in number, and are (as has been recently shown by Mr. Wray) in the very great majority of birds distributed as follows: Six, or in some few cases (flamingo, storks, grebes, etc.) seven, to the metacarpus; of the remainder or digital feathers, one (*ad-digital*) is attached close to the metacarpo-phalangeal articulation, and rests on the phalanx of the third digit; two (*mid-digital*) have their bases attached to the broad dorsal surface of the basal phalanx of the second digit, which is grooved to receive them; the remainder (*præ-digital*) are attached to the second phalanx of the same digit. These last vary greatly in development; in fact, their variations constitute the most important structural differences of the wing. In most birds there are two: the proximal one well developed, the distal always rudimentary; but the former may show every degree of shortening, until it becomes quite rudimentary, or even altogether absent, as in *Fringillidæ* and other "nine-primaried" birds, in which there are six metacarpal remiges, one ad-digital, two mid-digital, and no prædigitals, or only a very rudimentary one. The smaller feathers at the base of the quills, called upper and under coverts, have an equally regular arrangement. The webs or vanes of all the flight-feathers are made up of a series of parallel "barbs" which cohere together by means of minute hooklets, and so present a continuous, solid, resisting surface to the air.

Such is the characteristic structure of the wing in almost all carinate birds, whether powerfully developed for flight, as in the eagles, albatrosses, or swifts, or whether reduced in size and power to practically useless organs, as in the extinct great auk, the dodo and its kindred, weka rail, notornis, cnemiornis, etc., most of which, being inhabitants of islands containing no destructive land mammals, appear to have lost the principal inducement, and with it the power, to fly.

In the penguins (*Speniscomorpha*) the feathery covering of the wing entirely departs from the normal type. Each feather is like a flattened scale frayed out at the edges, the barbs are non-coherent and have no hooklets. They form an imbricated covering of both surfaces of the wing, including the broad patagium which extends from the cubital side of the limb, but appear to have no definite relation to the bones, and can not be divided into distinct groups, corresponding to those described above. The structure of the wing separates the penguins sharply from all the other carinate birds.

The *Ratitæ*, or birds without keel to the sternum, form another very distinct group, distinguished by the rudimentary or imperfect condition of the remiges or quills, which never have coherent barbs, and are therefore unfitted to the purpose of flight. In the ostrich and rhea the bones, though comparatively small, are distinct and complete, and the feathers large and definitely arranged. The emu, cassowary, and apteryx show various degrees of degeneration, which apparently culminated in the dinornis, no trace of a wing-bone of which bird has ever been found. The question which naturally presents itself with regard to these birds is, whether they represent a stage through which all have passed before acquiring perfect wings, or whether they are descendants of birds which had once such wings, but which have become degraded by want of use. In the absence of paleontological evidence it is difficult to decide this point. The complete structure of the bony framework of the ostrich's wing, with its two distinct claws, rather points to its direct descent from the reptilian hand, without ever having passed through the stage of a flying organ. The function of locomotion being entirely performed by powerfully developed hind-legs, and the beak, mounted on the long, flexible neck, being sufficient for the offices commonly performed by hands, the fore-limbs appear to have degenerated or disappeared, just as the hind-limbs of the whales disappeared when their locomotory functions were transferred to the tail. This view is strengthened by the great light that has been thrown on the origin of the wings of the flying birds by the fortunate discovery of the *Archæopteryx* of the Solenhofen beds of Jurassic age, as in this most remarkable animal, half lizard and half bird, the process of modification from hand to perfect flying bird is clearly demonstrated. The three digits, which in the existing forms are more or less pressed together and imperfect, still retain their freedom and complete number of phalanges, and are each armed with terminal claws, while the flight-feathers and remiges of the cubital, metacarpal, and digital series are fully developed and evidently functional. The earlier stages in which the outer digits were still present, and the feathers imperfectly formed or merely altered scales, are not yet in evidence.

Some conception of the process by which a wing may have been formed may also be derived from the study of the growth of feathers on the feet of some domestic varieties of pigeons and poultry.

MEASURING THE EARTH'S SURFACE.

By FRANCESCO SANSONE.

GEODETICAL science—that is, the particular branch of human investigation which is devoted to ascertain what are the exact form and dimensions of the earth—has not been slow to follow the general progress. The advance made in this branch of studies since it was first proved that the earth's form was spheric, and since Galileo uttered his historical "*Eppur si muove*," has been parallel to the advance made in all other branches of scientific knowledge and methods of investigation.

The first notions concerning the form of the earth were that its form was that of a tablet, ending abruptly at its extremities into what would be considered the abyss, which could not be reached by man. The idea that the earth was nothing but a plane was abandoned before the beginning of the Christian era. The earlier attempts at calculating the size of the globe were based on astronomical observations. It would be difficult to-day to say within what degree of accuracy the figures then obtained could have been relied upon, as the units of measurement used by those pioneers have been lost and could not be compared with the units now in use.

One of the earlier attempts at obtaining the actual length of the earth's meridian by direct measurement of a portion of the same was made in the sixteenth century by a French doctor. The means employed, although very ingenious, would be considered perfectly clumsy and inadequate by the modern scientist. There was in this early measurement no attempt at mathematical precision as understood in the present century, and, considering the simplicity of the method employed by the doctor, it is only to be wondered that no greater error was obtained in its final result. The measurement consisted simply in driving from Paris to Amiens, and counting the revolutions of the wheels of the carriage, and from the number of revolutions of the wheels obtain the distance between the two cities, which could serve as a basis for calculating the length of the meridian. Of course, this calculation could not by any means be considered accurate, but, taking into account the means employed, the result obtained has been subsequently found to be wonderfully precise. The most curious thing about it is, that what would now be considered grave errors and inexactitudes were so distributed that they almost compensated each other, and the dimensions then obtained show only slight differences with the dimensions given by the most recent measurements. Thus chance (and no better name could be found) permitted of the same results, with only a small final error, being obtained with that crude method, that are now obtained with the most precise instruments and with the most complicated calculations,

Geodetical triangulation is, like many of the other branches of scientific applications, essentially a child of the modern era. It is not older than the seventeenth century; the first application of geodetical triangulation to the measurement of an arc of the earth's meridian having been made in Holland at the beginning of that century. It was followed by similar measurements in England and in France, but in all these measurements the arc measured was never greater than two degrees, and the importance of such measurements on the question of the length of the earth's meridian could therefore not be considered very great. This fact was so keenly felt that the work done in France was extended both in a southward and in a northward direction at the beginning of the eighteenth century, and the distance between Dunkerque and Perpignan, the northern and southern extremities of France, was obtained by triangulation.

What is geodetical triangulation? If two sides and one angle, or one side and two angles, or three sides of a triangle, are known, the remaining parts of the triangle can be calculated by means of well-known formulas. It is on this property of triangles that geodetical or trigonometrical triangulation is based. Supposing the exact distance between two cities situated from one hundred to five hundred miles from each other has to be measured, it is not necessary to tramp the whole distance with a surveyor's chain or other measuring instrument. Such measurement would be too tedious, besides being incorrect, and could not be made in a straight line, even supposing that the ground between the two cities were all level, and that no obstacles intervened to render such straight-line measurement altogether impossible. But this difficulty can be obviated and the exact distance ascertained by means of triangulation. A number of intermediate points are taken, situated so that each three of them form a triangle in which the angles are not too small to be measured. The two ends of the line whose length has to be calculated are also used as points. A series of triangles is thus obtained, the sides of which are of course imaginary, between the points chosen. These points are called stations. The whole system of stations, and of the imaginary lines between these, is what is known as a triangular or trigonometrical net, because when drawn on paper all the lines between the various stations form a sort of net. If the actual distance between two of the stations of the net is known, and if the angles between any two lines of the net are measured by means of special instruments, all the distances between the various stations can be calculated, and thus the distances between any two stations, whether terminal or intermediate, can be ascertained.

However simple this work may seem in appearance, the difficulties to be encountered in its execution, and the probabilities of errors to be avoided, are so many that special scientific skill and thorough ability and training are required in those who have to undertake the practical execution of the work. Like much other scientific work, it has to be a work of love rather than a matter of duty on the part of the executors on whose observations the accuracy of the result necessarily depends. Dangerous ascents and solitary life on the top of high mountains, with no other society than that of the few assistants who accompany him, are common occurrences for the geodete. Not less dangerous to him is the ignorance and greed of the mountaineers, who, seeing his bright, well-kept instruments, imagine that they are made of gold, and often do not stop at any means to get possession of what they consider will make their fortune.

The progress made by mathematical science during the seventeenth and eighteenth centuries, and the great controversy raging then concerning the exact form of the earth, resulted in a serious attempt being made to measure arcs of the meridian at different places on the surface of the globe, and as much as possible near the central parallel, the equator, and the extreme parallel that could be reached, the polar circle. This work was undertaken by the French Academy of Sciences, and two expeditions were fitted out to undertake such measurements, one in Sweden and the other in Peru. The execution of the work was very accurate, considering the difficulties under which it was undertaken. Their purpose was to obtain the exact length of a degree at those different latitudes, and from these lengths the exact form of the earth. The results of the work done by the two expeditions were made known about the year 1750, and showed that the length of a degree near the equator was shorter than that of a degree in a northern latitude, the difference, expressed roughly and in a popular manner, being a little less than one per cent. This confirmed the theory which had been previously proposed, that the earth was depressed near the pole, so that, although this theory had been already advanced before the end of the seventeenth century, it was not generally accepted until it was shown to be correct by actual measurement. The impetus given to geodetical measurements by the last-named expeditions and by the results obtained was so great that geodetical work began to be done in earnest. The English triangulation was begun before the close of the last century. In India a short arc measurement was also executed about the same time.

The outbreak of the French Revolution, and the new ideas which it gave rise to, were the direct cause of the most interesting scientific work done at the close of the last century. As they abolished the privileges of classes, the new ideas tended also to abolish the privileges of systems, and a new system of computation was tried to be introduced which would give uniformity in division. This division was the decimal instead of duodecimal or others which had been until then the prevailing ones. Thus the year was divided into twelve months, and the month into three weeks of ten days each, the tenth day being made a civil holiday; the remaining five days of the year not being distributed in the various months, as with the Gregorian Calendar, but being put together as a civic yearly period of festivity at the end of the year, which was made to begin with the September moon, on the twenty-second day of September. The same was done as regards the system and units of measurement, value, etc.; but, while the time-divisions were made on a rather arbitrary basis, and have, therefore, not been able to supersede the older and more natural divisions, the decimal system of measures, weights, and values which was then introduced, rested on a thoroughly scientific basis, and has therefore been able to withstand all attacks and to gain introduction into the larger number of states into which Europe is divided. This system is the metric system.

Aside from the fact that the metric or decimal system permits of all sorts of calculations being made more quickly and easily, it possesses as its foundation a basis which is thoroughly scientific. The other systems of measurement are based on a more or less arbitrary standard, which may be indestructible, but which is liable to alter like anything made by the hands of mortal. But the basis on which the metric system rests can be supposed to be unalterable, being the earth itself as measured by the length of its meridian. The standard of unit in the metric system is the metre, the length of which is the $\frac{1}{10000000}$ part of the quadrant, or the $\frac{1}{40000000}$ part of the whole meridian. In order, therefore, to obtain the exact length of the metre, it was necessary to measure an arc of meridian of sufficient length to guarantee the exact calculation of the whole meridian. This arc, which had a length of nearly ten degrees, was measured between Dunkerque and Barcelona, the most prominent mathematicians of the time in France being intrusted with the execution. Although the greatest possible accuracy obtainable at that time was secured, the method of execution was not so perfect as those now in use. The metallic thermometer, invented by Borda, and which is described further on in the base measurement, was then used for the first time, but, instead of iron and zinc, the metals used were platinum and copper.

This arc was later on extended from Barcelona southward as far as the Balearic Isles by Arago and other French observers, who ran their net southward through Spain, and measured some very large triangles between the continent and the islands.

In all European countries geodetical measurements were made during the first half of the present century. To combine all these different lines measured by uniting them by means of special chains of triangles, and so obtain series of uninterrupted observations over a comparatively large area, was the work undertaken by Bessel in Prussia. This work possesses a high scientific and historical value on account of the thoroughness with which it was executed, and because the methods of execution then applied have become standard and have been accepted and imitated in modern geodesy. The geographical position of Prussia rendered the triangulation there of special importance as a means of connection between the different lines measured in the countries north and south, east and west of Prussia. This work was begun in 1831, and a connection was made between the French and Russian triangulations, and between the Danish and the South German nets.

Continental Europe has always taken the first place as the home of science; and scientific work, of whatever kind, can not fail to be duly appreciated there and to obtain that encouragement it necessarily needs. But Europe is politically so divided that the various states, however populous and powerful, are comparatively small in extent. For the accurate solution of geodetical problems vast areas and long distances are necessary, and these none of the European countries possess except Russia with its Asiatic dependencies. It has therefore been found necessary, in the interest of science, that the various countries combine together so as to have reliable observations extending over a vast area of territory which could be put together and aid in the solution of the problem that most interests the modern geodete—the exact form and size of the earth.

Although one by one the triangulations of each continental country were connected with those of the countries immediately surrounding it, there was no uniformity in the whole work until the proposal was made that all the countries combine together and act on a uniform scientific plan.

In the United States no geodetical work was done before the year 1831. The only arc measurement executed previous to that date was made by Mason and Dixon in the eighteenth century. It is a part of the line now separating the States of Maryland and Delaware, the direction of which is almost exactly north to south. The length of the arc was not over one and one half degree, and was measured directly with long wooden rods.

More recently the United States Coast and Geodetic Survey have been actively engaged in completing the measurement of an arc north to south and another east to west, the work done so far on the first bringing its length to twenty-two degrees, while the parallel arc across the continent will have when completed a length of forty-nine degrees. The advantages which these measurements in the United States have as scientific results are their great length, and, being executed by one authority, their uniformity in the methods of execution.

Although the principle is always the same, the methods of execution in geodetical work may show slight variations from one country to another. The following description of the field-work that has to be done is therefore of a general character, being intended to give the reader who is not familiar with mathematical studies, and with methods of measurement, an insight into the thoroughness with which geodetical work has to be executed, and the minuteness with which all the details of the work have to be carefully considered.

If the length of one side of a triangle is known, the length of the other two sides can be calculated, provided that at least two of the angles of the triangle can be measured by direct or indirect observation. It is therefore indispensable that a straight line be carefully measured, and the length of this line can be used as a basis by means of which all the distances between the various points or stations of the net can be calculated. This straight line that is actually measured in the field is used as the side of one of the triangles, and the other two sides are calculated with the help of the angles which can be measured by means of angular observations. The two sides of the first triangle, the lengths of which have been calculated, form with other imaginary lines other triangles, which may be designated as triangles numbers 2, 3, 4, etc. Each triangle has one side in common with the following triangle. Triangle number 1, for instance, may have one side in common with number 2, and one with number 3. If, therefore, the lengths of the three sides of triangle number 1 are known, these, together with the observations of the angles of number 2 and number 3, permit of the lengths of the sides of triangles number 2 and number 3 to be calculated, and so on.

The straight line that has to be actually measured in the field is known as a geodetical base. The accuracy necessary in the measurement of a geodetical base leaves all ordinary methods of which surveyors dispose altogether out of the question as too incorrect; a system of measurement has therefore to be applied which permits of the measurement being executed in a line scrupulously straight, of all variations in temperature which can affect the length of the measuring-rods being carefully noted and kept account of, and of the rods themselves being kept in a perfectly horizontal position. The measuring-rods are themselves very delicate and costly instruments. They consist of a prism of iron or steel, four metres long, on the upper surface of which another rod of metallic zinc rests, the zinc rod being somewhat shorter than the other, both being so placed on their supports as to prevent their bending and allowing them free expansion. The coefficient of expansion of zinc is much greater than that of iron, therefore the expansion or contraction of the zinc rod is much greater than that of the other. Changes in temperature in the two metals can thus be easily ascertained by actual measurement of the distance which separates the end of the zinc rod from a given point, marked on the iron rod. Four or six such rods are used for measuring a geodetical base. The rods are each in a long, wooden case, provided with micrometric arrangements for placing the rods in a straight line, raising or lowering the ends so as to have them perfectly horizontal; with spirit-levels, glasses, microscopes, etc. When the rods have been carefully placed in line, the distance between the end of one rod and the following has to be ascertained, and also, for getting at the actual length of each rod, the difference in the length of the iron and zinc rod in each of the cases. A small space is always left between two rods, which are not made to touch each other, in order to avoid sudden and too sharp contact. This intervening space, as well as the varying distance between the ends of the zinc and iron rods, is measured by means of small pieces of crystal a few inches long which have the form of half-prisms, being larger at one end and growing gradually smaller toward the other end. In fact, two of the four sides lengthwise have the form of a trapeze, while the other two are rectangles. One of these rectangular faces is divided to scale, and the observer has only to insert this piece of crystal between the two ends of the rods, without forcing it in, and to call the scale.

The same is done for noting the variation in temperature by measuring the space between the ends of the iron and zinc rods in each case. In order to leave no cause for error, the two ends of each rod are cut to sharp edges and made one vertical and the other horizontal, and the horizontal end of one rod faces the vertical end of the other. The same is done for the zinc and iron. When one of the cases is moved forward and placed in position ahead of the others, all the measurements between any two rods are repeated in order to detect whether any of the other rods has moved while the other was being placed in position. Spirit-levels are on each case, and their variation is carefully measured with microscopes. All the data are registered, and have afterward to be carefully gone over, and all compensations for error, temperature, etc., duly allowed. This apparatus is known as Bessel's base-measuring apparatus, the chief feature of which is the metallic thermometer with iron and zinc.

The length of a geodetical base varies according to the area to be covered by the net and to the possibility of finding a good ground for laying such a base. From five to ten miles would be considered a good geodetical base, one longer than the higher figure not being advisable on account of the possible increase in the inevitable error of such measurement. Even bases of about two miles have been measured, but these could not be used for very large triangulations, and are more intended as a check on other measurement and as a means of compensating errors. The ground has to be carefully leveled before the base can be measured. The two end-points of the base are marked by stone monuments which can be seen at a distance, and the whole length is divided into so many sections, each of which constitutes a day's work, stone and metallic tablets being laid and the line marked in advance before the actual measurement can be undertaken.

It is not necessary that the base should be actually measured before the real triangulation work—that is, the measuring of the angles at each of the stations of the net—is begun. The work of measuring a base is necessarily very slow. All apparatuses have to be carefully tested before being actually used in the field. Each of the rods has to be subjected to a series of experiments at different temperatures, in order to determine the actual expansion of the iron by comparison with that of the zinc. The actual measuring in the field occupies one or two months' time, and may be longer if the weather is not favorable, the whole distance, divided into sections, each of which constitutes a day's work, being measured at least twice, once in each sense. Five or six experienced operators are required, besides a number of assistants to do the menial work—such as carrying the rods forward, etc. The calculations are, later on, done in the office, and are in themselves a very slow and exhaustive process. Taking all together, the time required is little short of one year, including the preparatory experiments and the calculations.

When the base-line has been established and measured, and its terminals have been so marked with permanent material as to be practically indestructible, the base has to be developed—that is, a complete set of observations has to be made for the purpose of connecting the base with the stations of the net. The base being, as a rule, much shorter than the sides of the triangles of the actual net, it can not be connected directly with these large sides, as the triangles thus formed would have very small angles. A special net of triangles, the sides of which grow larger by degrees until they reach the large sides of the actual net, is established. This small net is given the form of a polygon for the purpose of increasing the accuracy. Longer bases are sometimes divided into two halves, and, besides the two terminals, a central station is established in the middle of the base, and thus three base stations are obtained instead of two. All the angular observations at the base stations, and at those which may be called stations of development, are made in the same number and with the same accuracy as in those of the net proper. They are all considered as first-class stations.

All geodetical points at which angular observations are made can be divided into four classes. In the first class are included all the base stations, the developing stations, and the actual stations of the geodetical net. The second class includes those stations which are of secondary importance geodetically, and which do not belong to the net proper. The observations at these stations are not so exhaustive as in first-class stations, although they are used also for controlling the observations of the others. Third- and fourth-class stations have more importance as topographical points, as they are used by the topographical operators as starting-points when mapping out the country. For scientific purposes, only the data collected at first-class stations are used, all others being rejected.

For ordinary topographical purposes, the number of angular observations at each station is not so large as when these have to be used for scientific purposes.

Except for the measurement of bases, geodetical triangulation consists almost exclusively in angular observations. In fact, it can be called essentially a measurement by angles, the work to be done, and on which many years may be spent before even a small net can be called complete, being an uninterrupted series of measurements of angles. Very delicate instruments are used in these measurements. The best part of an observer's outfit consists of a good theodolite. Although simple in principle, the theodolite is a very complicated instrument, and a good deal of practice is necessary to enable an observer to become efficient in handling this delicate machine. It consists chiefly in a good field-glass, which can be turned in every direction, so as to enable the observer to see the exact spots in the distance which are the stations of the net, and of a circle on which a scale, carefully divided, enables the observer to read the angle between any two directions in which the glass may be pointed. The glass may be turned toward any point on the horizon, and also in an upward or downward direction. The scale on the circle is read by means of two microscopes, diametrically opposite to each other. Spirit-levels, micrometric arrangements, etc., are provided, and the observer has to be very careful about placing his instrument in the right position before he can actually begin operations. Although the stations are not at the same altitude, the angles between any two directions have to be so measured as if the stations were all on the same level, on a perfect plane. This plane is supposed to be vertical to the earth's radius which crosses that particular station—that is, a plane tangent to the earth's circumference and perfectly horizontal. The movement of the field-glass has, therefore, to be such that, although two stations may be situated lower or higher, the angle between the two directions can be read as if each of them had been raised or lowered vertically to the level of the station from which the observations are being made. The circle of the theodolite represents this horizontal plane ; its center is supposed to be mathematically "the point," and the theodolite has, therefore, to be so placed that the center of this circle is in a perfect perpendicular to the point, while the surface of the circle itself is perfectly horizontal. The field-glass is situated on a support in the form of a double column, and the central axis of this support is vertical to the circle, and passes through its center. Delicate and exact mechanical arrangements permit of the glass being turned toward all points of the compass, and also of its being turned in an upward or downward direction ; but each movement is either in a horizontal or a vertical direction to the circle. This enables the observer to obtain the angle desired—that is, the angle which any two directions would give if all the stations were at the same level.

The length of the sides of the triangles varies according to the facilities for extending a good net which the ground offers. From twelve miles upward is a suitable distance, the distance being in some cases only limited by the visual power of the glass.

The scale on the circle is divided into degrees, minutes, and possibly seconds, the latter and their fractions being read with the microscope.

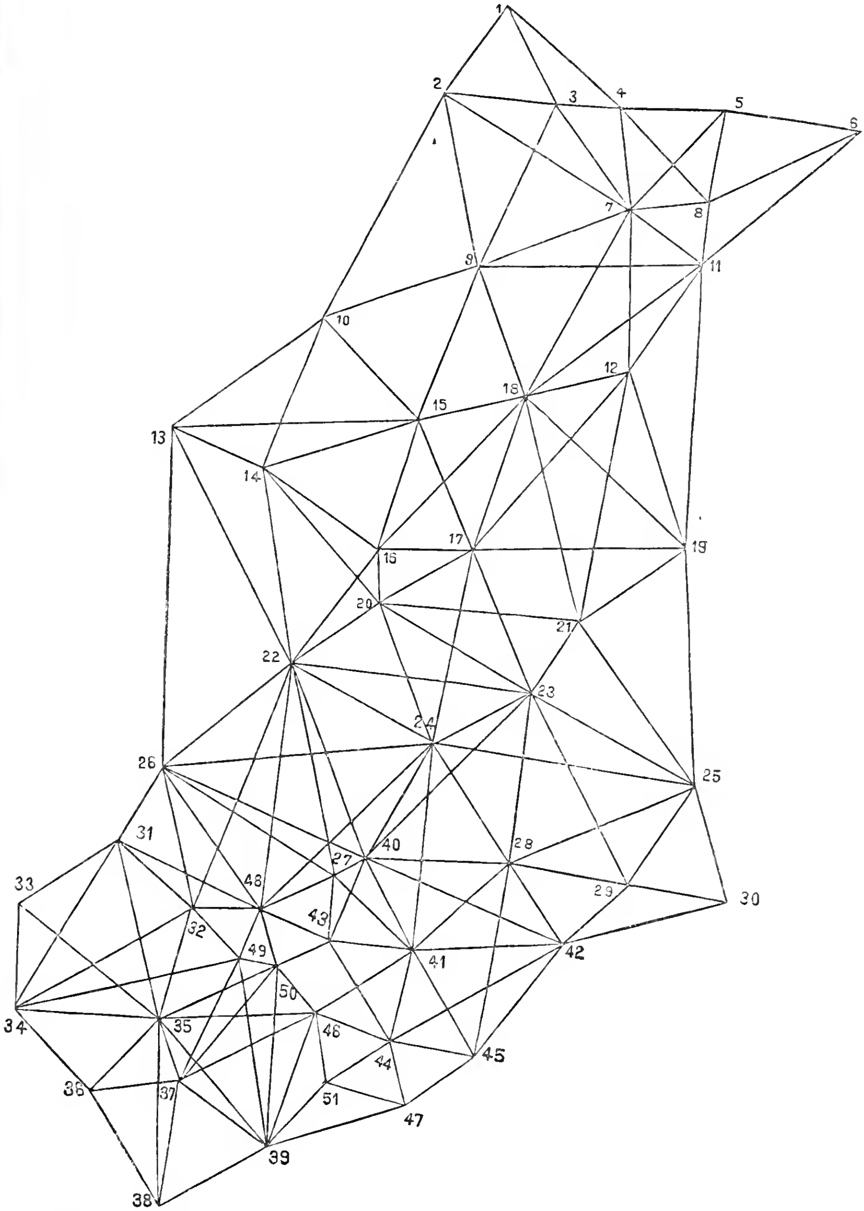
The angles are measured as follows : When the theodolite is placed in its exact position, and the circle is perfectly horizontal, the glass is pointed successively at each of the surrounding stations, and for every direction the scale on the circle is read and noted on the field-book. Supposing the scale reads 56° 18′ 12·075″ when the glass is pointed toward one station, and 115° 56′ 18·850″ when pointed in another direction, the angle between the two directions is equal to the difference between the two readings, which is in this case 59° 38′ 6·775″. These readings are repeated several times, the circle being every time moved around its center in order not to have all the readings on the same divisions of the scale. When a complete set of observations has been made, another set of observations is begun with the field-glass inverted. The observer places the larger end of the glass toward him, and turns the glass upside down around the axis, so that by this movement the smaller end of the glass comes to stay near the observer. With the glass thus inverted observations are repeated. The moving around of the circle and inverting of the glass are intended to avoid any errors which might be caused by faulty construction of the instrument, as, however costly and delicate the instrument may be, human skill can not make it mathematically precise.

When the angles have been measured, all the calculations have to be made for each triangle and for each polygon separately. Neither the work of mensuration in the field nor the calculations are what would be called work done by steam or by electricity. The season for the field observations being necessarily limited, each observer can not cover more than two or three first-class stations each year, as much as two months being often spent for one station alone when the climatic conditions are unfavorable. Angular observations for scientific purposes can not be executed in all weathers and at all hours.

Geodetical triangulation can be more successfully executed in mountainous regions, where the peaks act as natural observatories, and nothing interferes to prevent distant points being seen with the glass. Before the measuring of the angles actually begins, the net has to be laid out, the stations have to be visited, the most suitable point to be chosen and marked with some permanent sign. Stone blocks are used for this purpose, in the center of which a square metallic tablet is laid. The intersection of the two diagonals of the metallic tablet is the geodetical point. A small pyramid is sometimes placed in lieu of the tablet. In order to see the exact spot at a distance, a pyramid of wood or other material is built over the same, and a metallic rod, similar to a lightning-rod, situated in an exact perpendicular to the "point," is placed on top of the pyramid. This rod acts for all practical purposes as the real spot when the observer is at a distance. For stations situated in the plains, church-steeples, towers, or the tops of high buildings are used, and a given spot on these is chosen as the geodetical point, care being taken to choose only such points as are likely to be permanent for future reference, and are not liable to get out of the perpendicular.

The carefully executed observations described in the foregoing have to be made so accurate in order to avoid errors, which, although they may be allowed up to a certain limit when a topographical survey is alone being made, can not be allowed when the triangulation has to be made use of for purposes of getting at the real dimensions of the globe. An error which may be neglected on an area of a few hundred square miles is not permissible, and would be too large if multiplied to the whole length of the earth's meridian.

The accompanying illustration will serve to show what is a geodetical or trigonometrical net of triangles. It is not an imaginary net, but



one which has been actually laid out and measured. This net is a part of the work done by the United States Geodetic Survey, and is that portion of it which covers the whole State of New Jersey. It is copied from reports kindly furnished by Mr. G. H. Cook, State Geologist of New Jersey. It includes all the stations in New Jersey, and a few in the surrounding States, in all forty-seven stations. They are all first-class stations. To show how slow geodetical triangulation has necessarily to be, it may be stated that in the small State of New Jersey alone this work has been going on for nearly thirteen years, and is now nearly completed, only a few stations remaining to be covered at the beginning of the year 1886.

I may here state also that a few of the historical facts I have given are taken from "Elements of Geodesy," by J. Howard Gore, B. S., just published.

The idea of connecting the various measurements in the different European states was later on improved upon, and for the purpose of obtaining good, reliable data, collected on a system of uniformity sufficiently numerous and covering a large area of territory, all the states of Continental Europe have combined in the interest of science. If each country did its work separately, and the data obtained in one could not be compared with others, the observations made would have only a local value, and, being limited in extent, could not have that scientific weight which it is necessary they should have. All European countries have felt the necessity of having thorough topographical surveys made, so as to possess good, detailed maps of their territory. This work being considered necessary for military purposes, its execution has been undertaken by the military authorities. The triangulation work necessary for this purpose could, with little addition, be extended so as to connect the geodetical nets of the various countries and form a complete system of nets extending over the whole continent. An agreement was entered into, by the various states into which Europe is divided, that the geodetic data which were being collected and the observations that were being made should become common property, and that all the observations being made on a standard of uniformity agreed upon by all parties concerned, they should be used in common for the purpose of furthering the scientific problem and obtaining a series of nets, by means of which the exact distance between any two points on the European Continent could be easily calculated.

The common work—that is, the direction of the whole as an international undertaking, each country doing its own share within its own borders—has been confided to an international commission specially founded for the purpose, and which is known as the Commission Internationale pour la Mesure du Degré en Europe. All the states are represented in this commission, the representatives being mostly the heads of the geodetical department of each country, and some of the best-known astronomers. The best specialists of Europe, who have devoted their life to this branch of studies, belong to this commission.

The international agreement makes it possible to have uninterrupted chains of triangles across the whole continent, from north to south, and from east to west. It is, however, not necessary that the nets should extend over the whole area of each country. Neither the topographical necessities nor the scientific requirements make such a complete geodetical survey indispensable. Those countries possessing a comparatively larger territory would find a complete triangulation too costly and too slow. Each country has therefore laid its nets as it thought best. The Atlantic countries, France and Spain, have laid a series of parallel nets from north to south, and another from east to west, crossing each other almost at right angles. Supposing each of these nets to be drawn on the map, but instead of the various triangles a thick black line to be laid down as a sort of central line of each separate net, the whole systems would have the appearance of square grates or pigeon-holes. Germany and Austria have not observed the same rule; their lines are less regular in form, although just as convenient for the purpose. Italy and the smaller states have found it necessary to cover their whole territory, on account of their irregular geographical form, or their smallness. Sweden and Norway have run several nets, and also Russia; but the vast area to be covered leaves a thorough and systematic triangulation of the whole country out of the question.

The control which observations extending over such a vast area permit is very great. The possibilities of its being extended over a still wider field are only limited by political difficulties and by the great cost necessary for its execution in half-civilized countries. The result of the work undertaken by the International Commission can not fail to be of the highest scientific value, and the standing of the men who compose it is a guarantee that the greatest efficiency and thoroughness characterize the work done.

Of the calculations necessary, and which follow the field-work, the least said the better. To an outsider, one who is incapable of comprehending the scientific purpose of the same, they look very much like time wasted and which could have been better employed. It will suffice to say that all calculations are made twice and independently of each other. Each set of calculators do their work independently of the other, and only compare the final result. Months and months elapse before a partial result is reached, and before other and more complicated calculations can be begun. But the battle-field is one worthy of man; he has arrayed himself against figures, and, although slowly, he conquers them with the help of formulas, equations, and logarithms, all children of his fertile brain. The scientific result is obtained with scientific means. From beginning to end, geodetical triangulation is purely scientific; nothing is left to chance, and, although it can not by any means be mathematically precise, it comes as near the point of complete correctness as it is possible for any human thing to be.

SULLY'S HAND-BOOK OF PSYCHOLOGY.*

By CARVETH READ.

THE "Outlines of Psychology" was written, as the title-page showed, "with special reference to the theory of education." Sometimes in the midst of the text, but chiefly at the end of each chapter, abundant remarks and reflections were introduced, showing the bearing of the principles of mental science upon the training of faculty and character in the young. The work has been (as it deserved to be) very acceptable to the public—especially to students—and it would be a great mistake to suppose that the present "Hand-book" is intended to, or possibly can, supersede it. But it has been felt that the "Outlines," in spite of its modest title, is too long and detailed, and sometimes perhaps too abstruse and difficult, for many parents and teachers, who would gladly see their task in the light of science, but either have not much time to spare, or else lack the special training that is requisite for the more intricate questions of psychology. For them, accordingly, the present smaller volume has been produced.

The "Hand-book" begins with a discussion of the scope of education and of its relation to psychology. After this preliminary chapter the book is based upon and follows generally the course of the "Outlines," giving a succinct but luminous view of the best scientific doctrine with regard to the senses, perception, the higher intellectual powers, the emotions, and volition. But the applications of the science to the problems of education are no longer, as in the larger work, separated from the exposition of the science itself by any difference of type or arrangement. Doctrine and precept are fused into a continuous whole, which, assisted by an openly printed page and an effective style, becomes, I must say, extremely readable, considering the nature of the subject. Upon each branch of the subject enough is said concerning the principles of psychology to serve the ordinary purposes of the educator; and everything is said so simply that no one, however unaccustomed to such inquiries, can fail to follow and understand it. There is no attempt to enter into subtile disquisitions or vexed controversies. The bog-fires of metaphysic, hardly seen to glimmer on the borders of the demesne, can tempt no wayfarer to go astray. Every sentence is subordinated to the single end of clearing up the problem how best to train the minds and characters of the young. And the inferences drawn step by step as the book advances, and the suggestions made upon this most important of all subjects, are an admirable example of the application of science to life. Who can help wishing

* The Teacher's Hand-Book of Psychology. On the Basis of the "Outlines of Psychology." New York: D. Appleton & Co. 1886.

to have been born later, and to share the more enlightened instruction that awaits the next generation?

If I were to take exception to anything in the scientific aspect of this book, it would be chiefly to the treatment of conception, judgment, and reasoning, which seems to me too much under the influence of ordinary logic. But even here what seems to me questionable lies more in the expression than in the thought; and there is, after all, in this part of the exposition some advantage in availing one's self of the terms and distinctions of logic; since many readers will partly understand them to begin with, and will thereby be more readily familiarized with the abstruser ideas of psychology. Still, this advantage may be bought too dear. In the practical aspect of the book, I am inclined to say that it lays too much stress upon the importance of authority in moral training. But probably few of those for whom the book is intended will think the author's doctrine of discipline overstrict. His treatment of the emotions and sentiments in relation to education, a particularly difficult and important part of the work, seems to me especially good.

It is a striking fact, the sudden turning of so many first-rate minds to the subject of education; and a great revolution in scholastic affairs, however gradual, will certainly result from it. No subject ought to be so universally interesting. If none seem so tedious to us, it may be because our own education was so bad; or that we have reflected so little about it that new suggestions find in our minds no soil to strike root in; or that the complexity and practical difficulties of it paralyze our faculties: in any case, the more reason for spurring ourselves to the study. There is no subject more beset with popular errors, none in which science is more useful, explanatory, and suggestive. Not only every professional educator, but every father and mother (amateur educators!), ought to have some acquaintance with psychology. However absurd this seems, I defend it on the ground that nothing else enables one to interpret the faint and fragmentary recollections of having been one's self a child: without which how can other children be known, and, if unknown, how trained? At school I often used to wonder whether the masters had ever been to school, they knew so little of what we boys were thinking, feeling, and about to do. I have heard an educated woman say of her baby, squalling of course at six months old, "I believe he knows he's doing wrong." Heautomorphism, in default of science, is ever the first resource of explanation; i. e., we judge of others by ourselves. Discipline without knowledge, and therefore without sympathy, an outside wooden machinery, hampering and crushing, is the same in schools, in homes, and in prisons.

Science is certainly useful; yet it may be perverted by an ingenious mind. It has been urged that, according to the theory of evolution, education must with each generation become less necessary: I suppose, because the amount of inherited faculty grows greater. But this inheritance is only potential: its realization depends partly on education; and the more of it there is, the more education is requisite. The truth which the above opinion has mistaken is, that the power of education is limited both for good and evil by the nature of a child. But this truth the world did not wait for the theory of evolution to reveal. The notion that character and understanding depend wholly on the experience and training of the individual was never adopted by common sense. It is everywhere recognized that no education, however good, can insure against taking one of the by-paths of the Pilgrim's Progress that man who has some deep ancestral taint—"a bad avidge" one calls it in Cornwall (however that word should be spelled). On the other hand, the first rule for a successful educator is to get a good pupil. But this does not conflict with the further truth that the greater natural potency of development which accompanies civilization, makes the teacher's task not less necessary, but (as far as it goes) more exacting, requiring greater care and skill; since, first, the subject to be trained becomes more complex and delicate; secondly, the time during which it requires supervision increases; thirdly, the changes occurring in it during that time are more numerous and less predictable; and, lastly (not to seek further reasons), the world to which it is to be adapted grows far more complex and exigent. How rapidly the world has changed in the last three hundred years, and how little scholastic education has tried to keep pace with it! So much the more desirable is it that the changes now inevitable should be made in the light of scientific criticism.

To the scientific criticism of education Mr. Sully brings every requisite. A wide reputation as a psychologist guarantees the competence of his theoretical knowledge. A deep and varied culture in science, literature, and art enables him to survey the whole field of labor. He has for a long time studied education as a science, and in so doing has availed himself of all the work of his predecessors and contemporaries both at home and abroad. Whoever wishes to make an exhaustive study of the subject will find in the appendices to his chapters a sort of index to educational literature. Mr. Sully has, moreover, direct experience of the difficulties of education both in its earliest and most advanced stages. Many of the anecdotes that enliven his book bear the stamp of personal observation. And a humane and serious spirit everywhere dispenses wisdom as well as knowledge.

In this "Hand-book" education is, of course, treated in a broad and general way, covering both the early years of training at home and the later periods at school. But there would be manifest advantages in treating these ages and conditions separately with more specific detail. Again, while a work of this sort begins with psychological principles and then proceeds to apply them to education, teachers might be more readily interested by the method of beginning with the particular problems and difficulties of their art, and then exhibiting the principles involved in them; or of beginning with the rules of education that have been empirically collected and handed down, and then testing and evaluating these by scientific analysis. One great difficulty of education is how to deal with the various classes into which pupils fall as to their powers and groups of powers. The same treatment can not be good for all alike; but how to adapt it to each? We want an ethology of the school-room, somewhat more discriminative than that ethology of the assembly that Aristotle gives in his "Rhetoric." After that would come the question, What studies and combinations were suited to each type? But the field of suggestion is wide and the labor therein light.—*Mind.*

SKETCH OF M. ARAGO.

ON the 26th of February last the one-hundredth anniversary of the birth of François Arago was celebrated at Perpignan, France, his native city. A grand celebration of the day had also been planned at Paris, to be held under the direction of the scientific men and publicists of the capital, but the municipal subvention, on which its promoters depended for its expenses, was not granted, and it failed. Nearly seven years previous to this time, on the 21st of September, 1879, a statue of the philosopher and patriot, the work of M. Mercier, was inaugurated at Perpignan; and one year previous to it an eloquent eulogy on M. Arago was delivered in the Academy of Sciences by M. Jules Jamin.

DOMINIQUE FRANÇOIS ARAGO was born at Estagel, near Perpignan, February 26, 1786. His father, who was a sub-treasurer at Perpignan, put him to school quite early in the college of that city. At seventeen years of age he was admitted to the Polytechnic School after a brilliant examination, in which he exhibited a peculiar spirit of independence, rising to the point of chiding his examiner for unwillingness to question him on account of his delicate appearance. Some months afterward, when the proclamation of the empire was contemplated, circulars inviting the act were distributed and introduced into the school to be signed by the pupils. Arago refused to sign the paper, and was the leader among the pupils who took that position. General Lacuée, reporting the transaction to the first consul, demanded that the recusants be dismissed from the school. Bonaparte took the list, read it, and remarked: "We will only not send the first name up for promotion. We shall have to give these boys a little time to be converted. You others have turned too quickly."

Before the end of his course at the Polytechnic, Arago, whose abilities had impressed all of his teachers, was appointed a secretary in the *Bureau dès Longitudes,* where he became associated with Biot, twelve years his senior, who was destined to be his co-worker or rival, according to circumstances, during his life. In 1806 he and Biot were appointed by the emperor to co-operate with the Spanish commissioners, Chaix and Rodriguez, in continuing the measurement of the arc of the meridian, for the establishment of the metric system. In this expedition he found arduous work, and underwent hard sufferings from the fortunes of war, the story of which we will let M. Jamin tell further along. He returned to France in the summer of 1809, and was received into the Academy of Sciences, in departure from its rules, at the age of twenty-three years. The emperor, who always manifested a remarkable esteem for him, considering how he had behaved when a school-boy, appointed him Professor of Analysis and Geodesy in the Polytechnic School, a position, or the equivalent of which, he held for twenty years. He also became director of the observatory and delivered lectures on astronomy, which were heard with equal interest by astronomers and by persons who knew nothing of mathematics, and were fully understood by the latter.

In 1830 he took the place of Fourier as perpetual secretary of the Academy, in which position it became his duty to pronounce eulogies upon deceased members, the felicity of the style and the scientific accuracy of which gained for him a world-wide reputation.

In 1830 M. Arago became a member of the Chamber of Deputies for the *Pyrénées-Orientales*. He took his seat on the Extreme Left, and became a conspicuous advocate of measures tending to the extension of public liberty and to electoral reform. He was also prominent in discussions relating to the marine canals, public instruction, and railroads. When the revolution that expelled the Orleans dynasty took place in 1848, M. Arago was made a member of the provisional government by popular acclamation, and was given charge of the bureaus of the marine and of war. He took part in all the events of that stirring epoch, sat among the moderate members, opposed the most radical republicans, while he always enjoyed their respect, was a member of the executive commission appointed by the Constituent Assembly, and marched to the barricades at the head of his troops during the bloody days of June. But so many struggles and shocks had broken his physical and moral energies, and he afterward sat in the Legislative Assembly without taking an active part. He declined to take the oath to the new government in 1852, as inconsistent with his past acts and professions, and was excused from it, and was allowed to keep his place in the observatory unsworn. He died in the next year, October 2, 1853.

The scientific, personal, and social aspects of Arago's life have been admirably portrayed by M. Jamin in his eulogy, and most of what follows on those points is drawn from that address. The first scientific labors coming under his notice were in association with Biot, the continuation of Borda's investigations of the indices of refraction of gases, and the determination of the relative densities of the air and mercury, from which they were able to calculate theoretically the constant of the barometric formula. The two friends next were interested in the scheme of continuing the measurement of the arc of the meridian from the shore-line at Barcelona, where Delambre and Méchain had left it, to Majorca, and thence to Formentera. In the execution of this enterprise it became necessary to set up a beacon-light in the Island of Iviça, and to observe it from two points in Spain, forty leagues off. Arago established himself upon a rock called *Desierto de las Palmas,* the summit of which hardly afforded room enough for his tent and instruments. On account of the distance, the frequency of fogs, and uncertainty as to the exact direction, it was six months before he could get sight of the beacon. As soon as the measurements were made, Biot took the first results to France, leaving his colleague to finish the work at Majorca and Formentera. Then began for Arago a series of exciting adventures. War had been declared with Spain in 1808, and the Majorcans sought to arrest him as a spy. He had barely time to disguise himself, and, gathering up the papers containing his observations and his instruments, to take refuge on the vessel which had brought him to the island. Thence he escaped, with the aid of the ship-captain, to the citadel of Belver, where he passed several months, substantially a prisoner, in making his calculations. He was at last permitted to go to Algiers, where he embarked on a vessel of the regency under the name of a Hungarian merchant, with a false passport, along with a crowd of Mussulmans and renegades, to which were added two lions and a family of monkeys which the dey was sending to his ally the Emperor of France. The vessel was taken close upon Marseilles by a Spanish corsair, "which conducted its prize to Palamos and took Arago to a country where he was only too well known and from which he had nothing good to expect." He suffered great privations till the dey was informed of the state of affairs, and bullied Spain into setting the lions, monkeys, ships, and philosopher again on the way to Marseilles. They had reached that port when a mistral suddenly arose and sent the vessel to the coast of Sardinia, and thence to Bongie, in Algeria, where the new dey, not so friendly as his predecessor, was disposed to hold Arago as a prisoner. Finally, he was allowed to return to France, running a new danger from pursuit by an English cruiser, and at length to receive a welcome from his mother, "who thanked God for having preserved his life, after having had masses said for the repose of his soul; he returned with the triple consecration of having encountered danger, done his duty, and attained a scientific success beyond his anticipations."

In 1809 the phenomena of optics engaged especial attention, and Arago entered upon the study with the ardor of his nature and his age. He engaged in the investigation of the polarization of light, which no one had as yet been able to explain, but of which he reached a satisfactory and correct elucidation by the aid of the undulatory theory of light. At the time Arago approached this question, only a few of the facts bearing upon the undulatory theory had been determined, while the most of them were unknown, or hardly suspected. He had to begin by finding them out and classifying them, and so bringing himself gradually nearer to the primary ideas. "The work resembled the play of guessing at words, which all the company know but the person who has to find the word. The inquirer has to ply Nature with methodical questions, numerous and close, to extract her secret from her. No one was better suited to the performance of such a part than Arago; no one more obedient to experiment, no one more systematically rebellious to preconceived theories. He began by studying how natural matter becomes polarized, and found that it is when it is divided into two parts. If there is polarized light in one of these parts, an exactly equal quantity of it will be found in the other, both vibrating in perpendicular planes. This mode of division forms a physical law which is still known as Arago's law." From this law Arago drew two practical results. The first one is applicable to lakes and seas, the surface of which divides the light rays into two parts—the reflected part, which takes the color of the sky and vibrates horizontally; and a part which, having penetrated to the interior and having vertical vibrations, is returned to us with the color of the water. "Both parts are mingled, but a double-refracting crystal separates them, and we see in one of the images the reflected sky, and in the other the bottom of the lake and all that it contains." The second result is that the sun, reflecting only natural or unpolarized light, is a flame, an incandescent gas, and not an incandescent solid.

Arago next published his discovery of the phenomena of rotatory polarization, with the production of complementary colors, varying in properties according to the crystalline medium through which they are viewed. One of his experiments was applied to the edification of the public by the optician Soleil, who devised various fanciful designs on laminæ of gypsum, which, colorless in natural light, were transformed, under the working of the polariscope, into polychrome images having the most beautiful appearance. One of the favorite designs was the word "ARAGO" surrounded by a laurel-wreath.

"Rarely," says M. Jamin, "has an inventor ever reached the limits of his discovery. He looks for its consequences where they are not, he goes astray in the labyrinth where no thread guides him, he passes by the truth without perceiving it, and leaves to his successors to reap where he has sown. Like so many others before him, Arago left the great work he had labored at without completing it. He was endowed with unequaled clairvoyance, and divined discoveries before making them; but he had no patience for details: he opened mines without working them out, and began labors without pursuing them. His first curiosity once satisfied, he gave himself up to new curiosities. He resembled a traveler who glances over a virgin country, gives it a name, and hastens on to more distant horizons. All phenomena excited his imagination without holding him long. An experimenter by inspiration, a discoverer by instinct, he had too much passion, too little leisure, too fertile a spirit, but not enough of that obstinate perseverance that finishes what is begun. . . . Of theoretical ideas which include a whole science in a few general hypotheses, and leave an ineffaceable trace, he produced none, but sometimes repelled them, even when his own experiments led others to them." Biot, his former collaborator, took up Arago's experiments and worked them out in detail to the discovery of those more particular properties of polarization and the two rotatory powers which have been found of such useful application in the arts.

But neither Arago nor Biot was destined to work out the undulatory theory of light in all its significance and to the full explanation of the phenomena. That part fell to the young engineer Fresnel, who, rusticating in a village near Caen, in expiation of some political errors, passed his time in studying optics. He wrote to Arago, and received in return advice by which he profited so well that he shortly afterward published his memoir on diffraction. He and Arago then together made the experiments on interference, by which a theoretical explanation of polarization was obtained; but Arago, heartily with him at the beginning, was not able to follow him in all his conclusions, and left to Fresnel the honor of explaining the experiments which he had himself performed.

Oersted having discovered the power of the voltaic current to produce deviation of the magnet, and having thence deduced the theory of the relationship of magnetism and electricity, Arago took up his experiments. With a conductor of copper wire and a pile of iron filings, he learned that the current would also generate magnetism. He communicated his discovery to Ampère, and they made, with knitting-needles, those experiments in electro-magnetism which transformed a whole science, and cleared the way for the electric telegraphs, electric lights, electric clocks, and other instruments of to-day. One day an artisan of the engineers brought him a compass, which was nearly inert in its copper box, but lively enough in action when taken out of it. Experimenting with this apparatus to discover the cause of the compass's inaction, he discovered the magnetism of rotation—a discovery which Faraday complemented by showing how induction-currents are created in the copper.

The observation of a beautiful aurora borealis in 1817 gave Arago opportunity to verify the fact, which had already been observed and remarked upon, that the bands of light and the arch bore a relation to the magnetic meridian; to this he added the new observation that the magnetic needle was disturbed during the whole time of the prevalence of the phenomenon. On consulting the registers of previous observations, he discovered that similar perturbations had accompanied the aurora, even in places where it could not be seen on account of the weather, in the daytime, and in the polar regions. He recollected also that electricity is propagated in vague lights in vacuum-tubes and that these lights are deflected by the magnet; and he affirmed that auroras are electric sparks circulating in the higher parts of the atmosphere, oriented on the terrestrial magnet, and acting on the magnetic needle. This theory was attacked by Brewster, but Arago replied to his argument at length and convincingly.

The experiments which were entered upon for the purpose of measuring the force of the vapor of water were very important and very dangerous: important, because the safe working of steam-engines was dependent upon correct measurements of the force, and because all the properties of heat had to be passed in review; and dangerous, because they "imposed the task of confronting the unknown caprices of a formidable force. There were but two men to accept it and conduct it to success: Arago, who never shrank from a duty; and Dulong, already maimed by an explosion, whose previous studies had admirably prepared him for the new work." A rude manometer was extemporized, and a boiler, far less stanch than the steam-boilers of to-day, was set up, in which water was heated till the pressure was twenty-seven atmospheres. "They could not go further. At this extreme point, it leaked at all the joints, and the steam escaped through the fissures with a hissing that was of bad omen. But the observers, though aware of the danger, silent and resigned, finished without accident the measurements which they had begun." Telling M. Jamin the story, which was written out as above from his dictation, Arago said: "Only one being of our company preserved his serenity and slept quietly; it was Dulong's dog; they called him Omicron."

By the terms of the creation of the *Bureau des Longitudes*, the duties of the direction of the observatory and of delivering the lectures on astronomy were to be performed by the members in turn, a year at a time. Practically they fell continuously to Arago, and from 1813 to 1847 he delivered those lectures on popular astronomy which had a wonderful success, and of the life and vigor of which the tame rendering in the book of that name gives no idea. He did not write them out, but only prepared the outlines, and for the rest depended on the inspiration of the moment. They were attended by young men who went to learn, older men for the pleasure of hearing, and women, M. Jamin suggests, for the pleasure of seeing. "It was his habit, when he rose to speak, to select the least intelligent-looking face in the audience. He then never left it, but seemed to speak for it alone, and continued his demonstration, with various modes, till that face showed that its owner understood him; *a fortiori*, all of the auditory must have understood him as well.

Arago published, in the "Annuaire" of the *Bureau des Longitudes*, popular papers on natural phenomena and on the applications of science to industry. One of these dissertations was on thunder and thunderbolts. Another, which appeared in 1829, was on the history of the steam-engine; others were on rain, the cold of night, the ruddy moon, and the influence of the moon on terrestrial phenomena. He also published a paper on eclipses of the sun; and a total eclipse occurring in July, 1842, which could be favorably seen at Perpignan, he went there to observe it. Notice had already been taken of the aureole which appears around the moon during an eclipse, and to what are now known as the protuberances, and he gave his special attention to them.

Having been made perpetual secretary of the Academy of Sciences in 1830, he was accustomed to come early to the meeting every Monday, where he received foreign *savants*, read the correspondence, and, if it was his day, began the sitting with an analysis of the papers offered; and so clear and so much sought for were his analyses, that the memoirs sent up were frequently indorsed "For M. Arago's day." He also accompanied his analyses with a history of the questions discussed and a criticism of the proposed solution, the authority of which was never contested. In a short time this audience, though evidently illustrious, seemed to him too restricted. He desired to extend it. He had found a close Academy, working without witnesses, with doors closed or only half opened to a few privileged persons. He had them opened wide to all the world; and, in order that science might be spread more rapidly and further, he invited journalists to attend the meetings, and provided a place for them where they could take notes. He further, in 1835, induced the Academy itself to publish its proceedings under the supervision of the perpetual secretaries; and this was the origin of the famous "Comptes Rendus."

As a deputy and member of the political body, Arago proposed a scheme for damming one of the arms of the Seine and establishing a system of turbine pumps by which Paris should be fully supplied with water, which was defeated by a ridiculous jest. He induced the municipal council to bore the Artesian well of Grenelle, which was a great wonder in its day. He secured a public recompense for Vicat, who had invented an economical hydraulic cement. And when Daguerre came forward with his wonderful invention, which made it possible to take an exact portrait, by the aid of the sun, in fifteen minutes, Arago explained the method before the Academy and expounded its capabilities.

While a member of the Legislative Assembly, Arago was attacked with a malady which resulted in a gradual loss of sight, that became total in 1852. Being unable to make further researches, he endeavored to gather up and reduce to form the unfinished work of his past career. The visible results of this effort were seven conferences which he delivered in the Academy on photometry and polarization, and which were collated by Langier and published with his works. A final experiment, which was made under his direction a short time before his death, was to determine the relative velocity of light through the air and through water. Upon it was thought to hang one of the crucial arguments as between the corpuscular and undulatory theories. The result—determining that light moves more swiftly through the air—was in harmony with the undulatory theory.

Arago's contributions to scientific literature are to be found scattered as special papers recording his experiments, or brief treatises, in the "Memoirs of the Academy of Sciences," the "Mémoires de la Société d'Arcueil," the "Annales de Physique et de Chimie," the "Annuaire du Bureau des Longitudes," where his "Scientific Notices" appeared, and in the reports of his lectures of the observatory, which are embodied in the "Popular Astronomy." They were never arranged by him, but were collected after his death, and published in 1856–'57, in fourteen volumes, of which the "Popular Astronomy" forms the principal part. His chief work in science was in making special investigations, resulting often in brilliant discoveries, which served as the foundation and support of accepted theories. Besides this, he possessed a rare gift, which his friends and biographers claim to be an equal and a specific title of glory, of making scientific truths and conceptions comprehensible to the multitude, and this without sacrificing the dignity of science. He was a member of all the learned societies of Europe, and the particular friend of many foreign scientific men.

The best part of Arago's time was given, according to M. Jamin, to the duties of his professorship in the Polytechnic School. "In this often exacting position, he did not cease to be the object of affection for his good heart, and of admiration for the vigor of his teaching, the ease of his elocution, and the lucidity of his demonstrations. A former pupil himself, he loved his young comrades. It might be affirmed that he was an example to them by his thorough uprightness, judicial-mindedness, disinterestedness, and patriotism, qualities which he communicated, and which became as it were permanent characteristics of that admirable school. He defended it on every occasion, extolled it and looked at everything in its light. Whoever had come out from it was sure of kindness from him. On occasions of difficulty, when a general excitement threatened the discipline and future of the school, the pupils would go to the observatory for advice and protection, and were sure of getting them. He excited like admiration and found like esteem at the observatory." His weakness was, that he was subject to transitory fits of passion, which passed away and left no lasting trace.

EDITOR'S TABLE.

THE LESSON OF WIGGINS.

Do not let us put Wiggins away until we have learned all he has to teach us. He may not know much of meteorology or astronomy; he may be ignorant of the very elements of those sciences and of all science; but, it does not follow that he is not a great teacher in his way. The fact is, that the value of Wiggins consists precisely in his ignorance and general lack of sense; seeing that it is owing to these qualities, combined with a large dose of the most shameless assurance, that he is able to preach to us so eloquently regarding the condition of mind of a considerable portion of the community. There is no doubt that the Northern "Professor" has been taken seriously by thousands of honest people. The interest felt in his predictions was measured and reflected by the publicity given to them in the newspaper press. They penetrated into every town and hamlet in the country; and it was no doubt a true remark that somebody made the other day, that for one person who knew the name of the real astronomer, Proctor, ten knew that of the sham astronomer, Wiggins. If simple notoriety was the man's object, he has gained it to an extent which must have exceeded his fondest expectations. The only drawback to his fame is, that it is not so great by any means among his Canadian countrymen as it is with us. Like so many other prophets, his greatest honor has been achieved abroad.

A most remarkable fact in connection with the case is, that the credit of Mr. Wiggins should have survived the most signal and crushing falsification of his former efforts in the prophetic line. It will be within the recollection of some of our readers that he was to have brought on a storm and tidal wave of altogether unparalleled violence and extent some time in the month of March, 1884. He formally notified President Arthur of the impending calamity, which was chiefly to affect the North Atlantic coast of this continent; though there was also to be a tidal wave of unprecedented destructiveness in the Bay of Bengal. The men of real science were prompt in their repudiation of his predictions; they showed that his proposed storm was scheduled to take a course that no storm had ever taken before, and that, in the nature of things, no storm could take; but the fishermen of Maine and Massachusetts thought more of Wiggins than they did of the real representatives of science, and the consequence was that the fishing industry that year suffered not a little. All that came of these dire vaticinations was an ordinary equinoctial gale and a high tide (provided for in the almanac), that did a little harm here and there, but nothing of any account. The tidal wave ordered for the Bay of Bengal refused to put in even the most perfunctory appearance.

Yet, in spite of this, and of the most glaring demonstrations, at the time, of his ignorance, "Professor" Wiggins, who, as we understand, holds some minor clerkship in the Treasury Department at Ottawa, is able to come forward again this year, smiling and confident, with a brand-new set of predictions of the most sensational and preposterous kind. And people hear him—multitudes, at least—gladly. They like to think that the recognized authorities in science have not got things entirely their own way, and that their cautious and exact methods are not the only ones available for arriving at results. They welcome Wiggins because he aims not to instruct, but to excite and terrify—because he undertakes to tell them things about which other men are silent. The medical quack promises everything; the meteorological and astronomical quack threatens everything; and both achieve popularity. Human nature likes strong sensations.

Once more Wiggins has been put to shame, or put to what any other man would regard as shame; but what guarantee have we that he will not, after the lapse of a few months, don his prophetic robes again and fill the land with the noise of his foolish babblings? None: the probability is that we have not heard the last of Mr. Wiggins by a great deal. It will show a moderation on his part on which we have no reason to count, if he withdraws altogether from the notice of a public that is abundantly willing to forget his past blunders, on the sole condition of his propounding new terrors in complete disregard of all the principles of science.

What we see and lament to see in this whole business is, the evidence afforded of the very slight extent to which true scientific knowledge has as yet permeated the public mind. Large portions of our population are at the mercy of charlatans of every profession and of every type. Some of these prey upon their pockets, some upon their health, some upon their emotions. There is knowledge in the world that ought to be the heritage of all, but that really is confined to a few. The masses have no means of distinguishing between the man who speaks in the name of acquired and organized science and the man who uses a scientific terminology, that he himself only half understands, for the purpose of getting himself talked about. Their sympathies, however, rather go out toward the latter, for the simple reason that, instead of making his statements in guarded language, and building upon the previously ascertained facts of science, he throws all reserve to the winds, and speaks out of the fullness of his ignorance in a tone of the most absolute authority.

It seems trite to say that what is wanted is the more general diffusion of sound scientific knowledge; and yet, with the vast agencies that are now being employed in popular education, it should not be impossible, one would think, to do something to guard the community at large against ridiculous and hurtful delusions such as those which "Professor" Wiggins, with the aid of the press, has been instrumental in creating. We do not see why, in our public schools, some effective instruction might not be given in the spirit and methods of science. It might be shown how the early ages of scientific inquiry were marked by the predominance of the most extravagant fancies and ambitions; and that these had their use in stimulating to researches that would not else have been undertaken. Had the stars not been supposed to control human destinies, they would not have been made the object of so attentive a study in the ancient world. Had men not conceived the possibility of transmuting the baser metals into gold, the rise of the science of chemistry would probably have been long postponed. But to-day the true guide in scientific investigation is scientific analogy. The edifice of universal knowledge is being built up little by little through the contributions of patient students everywhere. To but few is it given to discover the operation of any widely acting law; and these are more prone to announce their discoveries in a modest, tentative fashion—as did Darwin when he published his "Origin of Species"—than to burst forth upon the world with loud and confident assertions.

It might also be shown how widespread and well-organized are the agencies now established for the study of physical phenomena, how many earnest men, equipped with all the knowledge of the age in so far as the sciences of meteorology and astronomy are concerned, are bending their attention upon the as yet unsolved problems of terrestrial physics; and how very unlikely it is that any great laws should elude their keenest research and most vigilant observation, and yet reveal themselves to an individual of absolutely no scientific standing, and, so far as any one can judge, a mere sensation-monger. A sketch of the history of science, of the order in which its leading discoveries have been made, and of its present resources for the further prosecution of truth, could, we doubt not, be rendered interesting to boys and girls of average school age. The sketch would have to be boldly drawn, in few and simple and striking lines; but this might be done without any sacrifice of accuracy. In this way respect for science as science would be created; and the rising generation would be made not only to feel that it is a power in the world, but to understand what kind of a power it is, and what kind of men its ministers ought to be. The lesson would have moral implications, for the methods of science are simply the best methods of every-day life, methods of patience, of perseverance, of honesty, of reason. To know science as an embodied power, as a personality, so to speak, would be to know that which one would necessarily be the better for knowing, and to be furnished with an ideal of life which, if not complete at all points, would embrace very much that is essential to integrity of intellectual and moral character. Thus, too, would public opinion be steadied and the credulity that is still the reproach of our civilization be reduced within much narrower limits. If Mr. Wiggins should, without intending it, be the means of so drawing attention to our educational deficiencies on the scientific side as to lead to vigorous efforts at reform and improvement, we shall be able hereafter to recall his name with feelings of less unmitigated scorn than would otherwise certainly be his due.

LITERARY NOTICES.

Letters and Journal of W. Stanley Jevons. Edited by his Wife. London and New York: Macmillan & Co. Pp. 473. Price, $4.

It is a most enjoyable treat to get a clear insight into the personality of a man who has made himself in any way distinguished, and to realize how like he, whom we have had to regard at a distance and as a kind of abstraction of the cause he is associated with, is to other men, and how fully he is in sympathy with all that is human. The enjoyableness is complete if the man's life has been happy and free from reproach. Such is the case with Professor Jevons as he presents himself in his letters and journal, in which his wife, supplying only such connecting links as were necessary, has wisely decided to give an account of his life in his own words as much as possible. They present him as a man of ordinary susceptibilities, with no extravagant or particularly marked tendencies in any direction, heartily enjoying his family life and his friends, fond of his baths, relishing active sports, entering enthusiastically into the volunteering movement which absorbed English attention while the world was waiting upon Louis Napoleon's nod, showing the musical as his strongest æsthetical taste, and patiently and persistently pursuing the work with which he gave life to the driest statistics and made the most abstruse social and economical facts luminous. The letters are full of good points, and show throughout the keen observer of men, facts, and events, of which the writer says but little, but that little going to the heart of the matter. After a residence of five years in Australia, Mr. Jevons visited the United States in 1859, two years before the beginning of the war. At Washington he "scrambled over the Capitol, the Washington Monument, the Smithsonian Institution, Lafayette Square, with Mr. Sickles's residence," and saw nothing more of the least interest in the American capital. New York he found a great but not very amusing city, while he admired the extreme convenience of the American hotels. Pittsburg was an intolerably smoky manufacturing town, and the great American towns generally were described as "mere collections of great warehouses, shops, wharves, and handsome dwelling-houses—in fact, merchants' offices and merchants' houses. The alpha and omega of the whole is trade." Mr. Jevons, as is well known, met an untimely death by what was called drowning while bathing in the sea at Galley Hall, near Hastings. His death is ascribed in this book to the shock of the cold water, which was no doubt too severe for his enfeebled health, and produced such an effect upon the weak action of his heart as to cause syncope and render him, after the first plunge, quite unconscious and powerless to help himself. The Rev. Robert Harley said of him, in the Royal Society, that he "was a man as remarkable for modesty of character and generous appreciation of the labors of others as for unwearied industry, devotion to work of the highest and purest kind, and thorough independence and originality of thought. The bequest which he has left to the world is not represented solely by the results of his intellectual toil, widely as these are appreciated, not only in England but also in America and on the Continent of Europe. A pure and lofty character is more precious than any achievements in the field of knowledge; and though its influences are not easy to trace, it is often more powerful in the inspiration which it breathes than the literary or scientific productions of the man." The editor of the "Spectator" said that he had other qualities than those of the philosophical thinker, "not always found in men of science, which make his character as unique as his intellect. At once shy and genial, and full of the appreciation of the humor of human life, eager as he was in his solitary studies, he enjoyed nothing so much as to find himself thawing in the lively companionship of his friends. Something of a recluse in temperament, his generous and tender nature rebelled against the seclusion into which his studies and his not unfrequent dyspepsia drove him. His hearty laugh was something unique in itself, and made every one the happier who heard it. His humble estimate of himself and his doubts of his power of inspiring affection, or even strong friendship, were singularly remarkable, when contrasted with the great courage which he had of his opinions; nevertheless, his dependence on human ties for his happiness was as complete as the love he felt for his chosen friends was strong and faithful. Moreover, there was a deep religious feeling at the bottom of his nature, which made the materialistic tone of the day as alien to him as all true science, whether on material, or on intellectual, or on spiritual themes, was unaffectedly dear to him." A bibliography of Mr. Jevons's writings, by the year and month, is given at the end of the volume.

The Origin of Republican Form of Government in the United States. By Oscar S. Straus. New York: G. P. Putnam's Sons. 1885. Pp. 149. Price, $1.

This treatise is an enlargement of a lecture which attracted much favorable attention when delivered first in New York, and subsequently before the Long Island Historical Society in Brooklyn. The author's purpose is to examine into the reasons why the republican form of government was originally selected by the people of the American colonies upon their separation from the mother country, in preference to every other form of polity. He ascribes such selection "mainly to ecclesiastical causes which operated from the time the Pilgrims set foot upon our continent, and to the direct and indirect influence of the Hebrew commonwealth."

Mr. Straus makes out a much stronger case for his hypothesis than might at first be supposed. He has industriously collected a good deal of pertinent historical matter tending to exhibit the religious causes of the American Revolution, to indicate the controlling Biblical ideas which influenced in one way and another the minds of the founders of the republic, and to prove how potent those ideas really were in molding the scheme of the new government. He has also traced out and made very evident some striking analogies between the United States government as finally constituted, and the Hebrew state under the judges. He considers, indeed, that the Hebrew commonwealth was the first well-developed democratic republic. This is seen in the divisions of general governmental functions, in the preservation of the tribal governments in federation under a national administration, in the recognition of civil equality, in the elective franchise, and in the separation of church and state—which last is a fact usually overlooked by students of Hebrew history.

Altogether the book is an exceedingly interesting and useful study; and the thought presented strikes out a fruitful and an unusual line of comparison. The author is never dogmatic, but his spirit is always that of the careful student and the scientific inquirer. As a literary production the work is admirable; the style is clear, the diction elegant and finished, and the reader's interest is well sustained to the end.

Paralyses, Cerebral, Bulbar, and Spinal. A Manual of Diagnosis for Students and Practitioners. By H. Charlton Bastian. New York: D. Appleton & Co. Pp. 671. Price, $4.50.

This treatise is intended as an aid to the student or medical practitioner when brought face to face with cases of paralysis of different kinds. Instead of setting forth in the fullest manner all that is known of the several forms of the disease, as may be done in special treatises, the author's endeavor has been throughout to facilitate diagnosis; to explain and gather up the essential points to be borne in mind by the student or practitioner when he is called upon to decide as to the nature of any case of paralysis, and give a prognosis concerning it. The various forms of paralysis are now so numerous, and so many advances have been made in our knowledge in the directions of their origins, that some such aid to diagnosis may well be looked for by those for whom this work is intended. The signs of paralysis of the different cranial nerves have been pretty freely dealt with, because the recognition of such paralysis, either alone or in association with paralysis in other parts, is often a matter of the greatest importance. As a knowledge of nervous diseases of the kind now looked for can not be attained without something more than a superficial acquaintance with the anatomy and physiology of the spinal cord, a plenitude of details, especially of anatomical details, is necessary in such a treatise as the present one is intended to be. The comprehension and recollection of these details have been facilitated, as far as possible, by illustrations. The threefold division of the subject suggested in the title is followed in the text; and, to the sections there indicated, another is added on paralysis due to lesions of the cranial nerves. The general course of the discussion of the subject is outlined in a few pages of introduction. Paralyses of encephalic origin are then taken up, with reference, first, to the several conditions that cause them, and next to the diagnosis, or the clinical considerations favoring the existence of this or that causative condition. The pathological diagnosis is considered as applied, in the apoplectic stage, to primary and secondary comas, and again after or in the absence of an apoplectic stage. Under the head of regional diagnosis are discussed the regional or localizing value of special symptoms that may be associated with the paralysis, and the clinical indications favoring the diagnosis as referred to lesions in parts supplied by the cortical and the basal arterial systems, and by the vertebral and basilar arteries, respectively. In the sections on paralyses of bulbar origin, the regional diagnosis is treated with reference to the diagnostic indications derivable from a consideration of the blood-supply of the bulb. Paralyses due to lesions of the cranial nerves are described with reference to the particular nerves involved. The pathological diagnosis of paralyses of spinal origin is described with reference to extrinsic causes and intrinsic causes. In the last hundred pages, full and particular accounts are given of the spinal diseases associated with paralysis, together with tabular exhibits of the diseases and of their relative acuteness or chronicity.

The Butterflies of the Eastern United States. By G. H. French. Philadelphia: J. B. Lippincott Company. Pp. 402. Price, $2.

By "Eastern United States" is meant, for the purposes of this manual, all east of the western boundaries of Minnesota, Iowa, Missouri, Arkansas, and Louisiana; and the region differs from the Atlantic province of Dr. Packard by the variance between State lines and a more sinuous line of elevation, and by the inclusion of the whole of Florida and the New England States and the exclusion of all of Canada. The book appears to have grown up in connection with the author's class-work in the Southern Illinois Normal University. It embraces a brief description of the several stages of butterflies and of methods of capture and preservation, an analytical key, and a more complete description of all the species that have been found in the region included. The introductory chapter describing the general characteristic and life of butterflies and methods of capturing and treating them is followed by an accentuated list of the butterflies of the Eastern United States, and this by the particular descriptions of genera and species. In the last part, the "preparatory stages," being often essential to a proper understanding of the relations that species bear to one another, and adding much to the interest of the study, are given so far as they are known.

The Industrial Situation and the Question of Wages. By J. Schoenhof. New York and London: G. P. Putnam's Sons. 1885. Pp. 157. Price, $1.

In the papers comprising this volume, Mr. Schoenhof has made a valuable contribution to current tariff discussion, in combating the wide-spread belief that high wages necessitate a high labor-cost in production, and therefore debar a country paying them from competing with a country in which wages are lower. Protectionists have worked assiduously to instill into the minds of the laboring classes the belief that the high rate of wages prevailing in this country is directly dependent upon the tariff, and that, once this prop gone, the laborer must sink to the condition of his European brother. And they have been so far successful that protection has been steadily able to hold its sway in spite of its manifest absurdities and the warring of conflicting interests.

Mr. Schoenhof points out the very obvious fact that it is only the cost of the labor entering into an article which has any bearing upon successful competition in the market. Now, the labor-cost not only may be low along with high wages, but, as a matter of fact, it generally is lowest where the wages are highest. This apparently anomalous state of things is due to the greater perfection of machinery and the greater skill and energy of the workmen in countries paying the higher wages. England, with considerably higher wages than is paid upon the Continent, is yet able to undersell its competitors there; and the United States is able to produce at a lower labor-cost than England. Here machinery has reached its greatest perfection, and the workman has acquired the highest degree of skill and capacity for turning out a large amount of work. The advantages which should accrue to this country from this state of things are, however, neutralized by the taxes upon the materials of production. With free raw materials, Mr. Schoenhof maintains that this country can compete successfully in the markets of the world with any other, and that it is manifestly to the interest of the working-man that we should have as extensive a market as possible. This is the guarantee to him of continuous employment, which is the essential thing for him. He has nothing to fear from a competition with the "pauper labor" of Europe, as already his labor embodied in the product is less than that of this same "pauper labor" in the competing goods of low-wage countries.

The thing the American workman has most to fear is the limitation of the market for his productions, and this is just what protection is securing for him. In support of this general position, Mr. Schoenhof reviews the two staple manufacturing trades, those of metals and textile fabrics, and produces convincing evidence of the correctness of his view. The author writes clearly and to the point, and his reasonings and facts should have the attention alike of the manufacturer and his employé, who are both injured by the protection they persist in believing is for their good.

Architecture, Heating, and Ventilation of Institutions for the Blind. By J. F. McElroy. Adrian, Mich.: "Times and Expositor." Pp. 21.

The author is Superintendent of the Michigan School for the Blind, and this pamphlet contains his address before the last meeting of the American Association of Instructors for the Blind. The first point in the architecture of the institution is, that the building should be constructed primarily with reference to its internal requirements, to which the exterior should be only the dress. The internal arrangement should look to spacious and convenient accommodation, free ventilation, proper heating, healthfulness, and the suppression of disturbing noises.

Selections for Written Reproduction. Designed as an Aid to Composition Writing and Language Study. By Edward R. Shaw. New York: D. Appleton & Co. Pp. 102. Price, 75 cents.

Explaining the theory of his book, the compiler says: "One of the best means of language-training is reading a selection to a grade or class, and requiring them to reproduce it in writing. The value of such exercises consists in the natural and easy way in which the pupil gains a command of language. Written reproductions from memory form the best basis to lead into original composition, and what, moreover, is of the utmost importance, they give the pupil an opportunity by his own practice to discover his errors and inaccuracies, and to work out of them. Through careful and suggestive criticism by the teacher, all the principles of composition become known; not, of course, in a formulated way, but in that way which gives the pupil power to avoid errors without being hampered by rules." The aim has been to supply a series of exercises suitable for such reproductions. The book is divided into three parts, of which the first consists of selections purely narrative or descriptive in character, such as experience has proved are best adapted for beginners. In the second part, the selections contain quotations, and are more difficult of punctuation; and the third part contains matter adapted to advanced grammar grades and classes in rhetoric. Suggestions to teachers are given at the beginning of each part.

United States Commission of Fish and Fisheries. Report of the Commissioner for 1883. Washington: Government Printing-Office. Pp. 1206, with numerous Plates.

The Commissioner reports a great extension of the possibilities of usefulness of the Commission, by means of the steamers with which it has been furnished; and much has been attempted as well as accomplished. In addition to the regular work of the Commission, it has become possible to do a great deal for the advancement of science in general, especially by prosecuting researches into the general natural history of animals and plants. The very large collections made by the Commission, after setting aside a full series for the National Museum, have been divided into arranged, classified, and labeled sets, and distributed to colleges, academies, and other institutions of learning throughout the United States. Among the objects which the Commission hopes to accomplish are the continued acquisition of information respecting fresh- and salt-water fish; improvement of old methods and apparatus of fishing and the introduction of new ones; improvement in the pattern of fishing-vessels; to determine the extent and general character of the old fishing localities, and discover new ones; to improve methods of curing and packing fish for market; and continued increase in the supply of valuable fishes, etc., in the waters of the United States. The present report contains many articles of general value. Among them are accounts of the species of fish cultivated and distributed in 1883; accounts of the work of the steamer Albatross, by Lieutenant-Commanding Tanner, and of its results in natural history and biology, by A. E. Verrill and Katherine J. Bush, liberally illustrated; and reports on the propagation of food-fishes at the several stations. Doubtless, these papers, a large number of which are published as an appendix to the report, are all of great value to some persons; but they are not of equal value to all. It is not desirable that any one wishing for one or a few of them should be burdened with so unwieldy a volume as the one before us. It would perhaps be as well to publish many of them in separate volumes, accessible to the general public, as well as in the ponderous shape in which they now appear.

Fourth Report of the United States Entomological Commission. By Charles V. Riley. Washington: Government Printing-Office. Pp. 550, with Plates.

This report is essentially a revised edition of the Commission's Bulletin No. 3, and is the final report on the cotton-worm, together with a chapter on the boll-worm. The cotton-worm investigation was begun in the spring of 1878, under an appropriation of five thousand dollars, and has been conducted with the purpose of getting at the exact truth, and for practical ends. Hence purely entomological knowledge has been subordinated to that which may be made of practical use to the planter; and descriptive matter and technical discussions have been for the most part excluded from the body of the work and printed at the end of the volume in notes. The wider application than that to the special object of the research of which many discoveries are susceptible is illustrated in the modern very general use by farmers and fruit-growers, in all parts of the country, of pyrethrum in the field, of petroleum emulsions, and of the cyclone spraying-nozzle, all of which have had their origin in this investigation. The report gives a full account of the cotton-worm, its character, habits, and history; of the influences that affect it, its natural enemies, the preventive measures to be taken against it, and the remedies, and machinery, and devices for accomplishing its destruction; a chapter on the boll-worm; and a number of special reports in the Appendix.

Duffy's Wave-Motor as a Source of Power for Various Purposes. By Terence Duffy. San Francisco: 918 Gerry Street. Pp. 15.

Mr. Duffy has sought an invention to utilize the enormous energy of waves as a source of power, and for the movement of mechanism. He has devised a buoy, with internal arrangements and machinery by which a set of pumps shall be set in motion by the undulations to which it is subjected, to supply a reservoir of compressed air; this air to be applied to any purpose for which it may be desired. Among the applications suggested in the pamphlet are the generation of electricity; signal, relief, and light stations; propulsion of vessels; and the movement of machinery on shore. The structure of the buoy, with all its chambers and mechanism, and the application to these purposes, are set forth in the pamphlet. We see nothing in the text, however, from which we are enabled to affirm that the author has set up one of his buoys and put it to an experimental test.

The American Journal of Biology. Quarterly. Edited by H. D. Valin, M. D. Chicago: Published by the author. $1 a year.

The "Journal," according to the editor's prospectus, is devoted to the study of life and mind in its widest sense, and will consist mainly of articles written especially for its pages by persons competent to treat the subject. Each number is intended to contain sixty pages. The present number is published with only forty-four pages, but with a promise to make up the deficiency in the next number, which will consist of seventy-six pages. It contains papers on "The Laws of Life outlined," "Origin of Flowers," "Nature of Animal Colors," "Nature of Light," "Development of the Eye," and "Nature of Sight," and selections.

Mechanics of the Girder. A Treatise on Bridges and Roofs. By John Davenport Crehore, C. E. New York: John Wiley & Sons. Pp. 575. Price, $5.

In this purely technical treatise, the necessary and sufficient weight of the structure is calculated, not assumed; and the number of panels and height of girder that render the bridge-weight least for a given span, live load, and wind-pressure, are determined. The book is presented just as it was left at the author's death, in October, 1884, with the carrying out of only a few examples in the twelve classes of girders still remaining to be done. Of these examples, the post-truss promised to yield the most prolific results; and it may be possible, the editor hopes, "before another edition is published, to complete this calculation at least, if not to introduce other examples from the later classes. However, the *a priori* method of the author is fully set forth previous to the tenth chapter; and it is believed that no one else has as yet published any so satisfactory results from this method, if, indeed, the method has been hitherto attempted with any degree of success." The work has been prepared for the press under the supervision of Professor John N. Stockwell, who has also undertaken the task of completing the remaining examples for future editions.

Bulletin of the United States Geological Survey. Nos. 27, 28, and 29. Washington: Government Printing-Office. Pp. 80, 59, with Plates and Map, and pp. 24, with Plates.

No. 27 is an account of the work done in the division of Chemistry and Physics, mainly during the year 1884–'85. Among the papers are one on "Topaz from Stoneham, Maine"; a memoir, by F. A. Gooch, on the separation of titanium and aluminum; investigations by C. Barus and V. Strouhall on electrical resistance and density, and oxide films on steel; and miscellaneous analyses. No. 28 is an account of the gabbros and associated hornblende rocks occurring in the neighborhood of Baltimore, Maryland, by Professor George Huntington Williams, of Johns Hopkins University. No 29 is a memoir on the fresh-water invertebrates of the North American Jurassic, by Charles A. White, M. D.

Disinfection and Individual Prophylaxis against Infectious Diseases. By George M. Sternberg, M. D. Concord, N. H. Pp. 40.

This essay is published by the American Public Health Association as one of the four papers on as many subjects of public sanitation, for which the prizes offered by Mr. Henry Lomb, of Rochester, New York, were awarded. The author, who has long been pursuing a scientific and practical study of all that relates to microbic infections, has in it explained the nature and office of disinfection and disinfectants, with the value and effect of the different substances in general use, and directions for application and for individual prophylaxis against the infectious diseases which man is liable to contract. The essay is designed for general use, and is, therefore, free from technicalities, and is for sale at "a price covering the cost," which we do not find specified.

The Relation of Hospitals to Medical Education. By Charles Francis Withington, M. D. Boston: Cupples, Upham & Co. Pp. 47.

Dr. Withington starts out with the proposition that measures not distinctly contemplated by the founder of a trust may, in the course of time or by changes in conditions and circumstances, become necessary to the truest fulfillment of the spirit of the trust. Among such measures is the use of hospitals as aids in medical education. Two objections may be brought against this view: one, that while the advancement of medical education is for the advantage of all men, there is no special obligation resting upon hospitals more than upon the general medical profession to contribute to it; and that the use of a hospital for such purposes may be in conflict with the comfort and well-being of the persons under treatment. These objections are answered: First, it is held that, since hospitals possess certain facilities for the advancement of medical science, having relation to important elements in medical education that are not enjoyed elsewhere, they are under a peculiar obligation to second this work; next, the possible conflict between the interests of medical science and those of the individual patient is considered, and the latter's indefeasible rights are defined; and in a third section the factors increasing the educational value of hospitals are discussed.

The Journal of Physiology. Edited by Michael Foster, M. D. Vol. VII. Nos. 3 and 4. Cambridge, England. Pp. 164. Price, $5 a volume.

Dr. Foster has the co-operation in conducting the "Journal of Physiology," in England, of Professor W. Rutherford, of Edinburgh, and Professor J. Burdon-Sanderson, of Oxford; and in the United States, of Professor H. P. Bowditch, of Boston; Professor H. Newell Martin, of Baltimore; and Professor H. C. Wood, of Philadelphia. The numbers appear, not at rigidly fixed times, but at varying intervals, which are determined by the supply of material. The two numbers now under notice contain fifteen articles descriptive of original physiological research, by W. M. Bayliss and J. R. Bradford, J. W. Barrett, C. A. MacMunn, M. Greenwood, S. Pallitzer, Sydney Ringer, F. W. Ellis, Francis Warner, W. D. Haliburton, and R. Norris Wolfenden. The papers of most general interest are, perhaps, those of S. Pallitzer on "Curare," and R. Norris Wolfenden on "The Nature and Action of the Venoms of the Indian Cobra and the Indian Viper."

First Annual Report of the Forest Commission of the State of New York for the Year 1885. Townsend Cox, Sherman W. Knevals, and Theodore B. Basselin, Commissioners. Albany: The "Argus" Company. Pp. 362.

The commission was appointed in pursuance of an act of the Legislature of May 15, 1885, and held its first meeting on the 23d of September of the same year. Its functions, as defined in the act constituting it, are to have the care, custody, control, and superintendence of the forest preserve; maintain and protect the existing forests and promote the further growth of forests; also to have charge of the public interests of the State with regard to forests and tree-planting, and especially with regard to forest fires in every part of the State; and it is given power to make these functions effective. The forest preserve of the State consists of various tracts of State lands in eleven counties in the Adirondack region and three counties in the Catskills. The part known as the Adirondack region covers a territory circular in its general outline and about one hundred miles in diameter, having its center near the northeast corner of Hamilton County. With but little exception, it is an unbroken wilderness, reaching from Lake Champlain westward to the valley of the Black River. That part of the Catskills which belongs in the forest preserve is situated about forty miles west of the Hudson, and occupies the northwest corner of Ulster County, together with parts of the adjacent counties. The Adirondack region proper contains more than four million acres, of which the State has acquired title to more than eight hundred thousand acres. In the Catskill region the State owns more than five hundred thousand acres. These amounts do not include the county lands in the Adirondacks and Catskills. Not all the land is forest-land. Much of it is abandoned and partly cleared farming-lands, much burned lands, and a large percentage of it abandoned timber-lands through which the lumberman has passed, taking all of the valuable soft timber and much of the hard. As years go on, and these woods are protected from spoliation and damage, the young, soft-timber trees will grow up and the forest assume its primitive condition. The rest of the territory is clothed with the dense original growth. Many good roads traverse the region, but few railroads penetrate the wilderness to any considerable extent, and none cross it. The forest preserve is made up of many disconnected plots, more in some counties than in others; plots ranging from a few acres up to many thousands, surrounded usually by lands owned by individuals, and in many cases inaccessible by roads. In other cases individual lands are entirely surrounded by State lands. Among the causes which tend to decrease the area of the forest-lands within the counties of the forest preserve are mentioned fires—the most frequent and the most destructive of them all—windfalls and land-slides, lumbering, tanning—which is the occasion of considerable waste—manufacture of wood-pulp, charcoal-burning and roasting ores, railroad-building, and farming. Although the forestry enterprise was at one time an object of opposition from the people of the Adirondack counties, a better acquaintance with the subject has wrought a modification in their feelings, and the report mentions as a matter worthy of note and congratulation that the commission is to-day receiving a hearty and intelligent support from the lumbermen and land-owners of the Adirondack region and the Catskills. Appended to the report are a list of the books and magazine articles pertaining to forestry to be found in ten of the large public libraries of the country, and a list of lands in the forest preserve, with a map of the Adirondack lands.

Report of the United States Entomologist for the Year 1885. By Charles V. Riley. Washington: Government Printing-Office. Pp. 150, with Plates.

In the report we find an essay on silk-culture, followed by notices, under the heading of "Miscellaneous Insects," of the destructive locusts or grasshoppers; the periodical cicada (or seventeen-year locust); the leather beetle, a new enemy to boots and shoes; the garden web-worm, the dark-sided cut-worm, the strawberry weevil, and the pear-midge. The "reports of agents" include notices respecting locusts at various points, insects affecting the fall wheat, the causes of destruction of the evergreen and other forest trees in Northern New England, and experiments in apiculture. Under the latter head Mr. Nelson W. McLain records, among other matters, experiments which he made to ascertain whether bees do harm to fruit. His bees were tempted with grapes, while other food was withdrawn from them, and the conditions of a severe drought were produced upon them. "They daily visited the fruit in great numbers, and labored diligently to improve the only remaining source of subsistence. They inspected and took what advantage they could of every opening at the stem or crack in the epidermis, or puncture made by insects which deposit their eggs in the skin of grapes. They regarded the epidermis of the peaches, pears, plums, and other fruits having a thick covering, simply as subjects for inquiry and investigation, and not objects for attack. If the skin be broken or removed, they will, in case of need, lap and suck the juices exposed. The same was also true of the grapes if the skin was broken by violence or burst on account of the fruit becoming overripe; the bees lapped and sucked the juices from the exposed parts of grapes and stored it in the cells for food. They made no attempt to grasp the cuticle of grapes with their mandibles or with their claws. So, in every experiment, bees were found not able to puncture the skins of fruits, or even to take advantage of punctures made by other insects, unless they were of considerable size."

Report of the Proceedings of the American Historical Association. Second Annual Meeting. By Herbert B. Adams, Secretary. New York: G. P. Putnam's Sons. Pp. 73. Price, 50 cents.

The meeting was held at Saratoga, New York, from the 8th to the 10th of September, 1885, and was attended by fifty members, representing various parts of the country, many institutions of learning, and several historical societies. The meeting of the American Social Science Association at the same time and place, and the attendance of several American librarians whose meeting was in session at Lake George, are mentioned as features adding to the interest of the occasion; and the organization of the American Economic Association under the same roof with, and in the reading-rooms of, the American Historical Association, at hours not conflicting with the latter's appointments, was another notable event in the records of the conventions. All of these bodies are in harmony with one another, and to a certain extent co-operative and complementary of each other's efforts. The report contains abstracts of the papers that were read at the meeting: By President Andrew D. White, on "The Influence of American Ideas upon the French Revolution"; by Goldwin Smith, on "The Political History of Canada"; by Jeffrey R. Bracket, on "Certain Studies in the Institution of African Slavery in the United States"; by Justin Winsor, on certain old maps; by Professor Tuttle, of Cornell University, on new materials for the history of Frederick the Great of Prussia; by Professor Emerton, of Harvard University, on Janssen's account of the Protestant Reformation, and the work of Luther; by Bishop Robertson, on "The Purchase of Louisiana, and its Effects upon the American System"; by Miss Lucy M. Salmon, on "The History of the Appointing Power of the President"; by John Addison Porter, on "The City of Washington: its Origin and Administration"; by Mr. Irving Elting, on "Dutch Village Communities on the Hudson River"; by Dr. Josiah Royce, on "The Secret History of the Acquisition of California"; by Dr. J. F. Jameson, on the study of the constitutional and political history of the individual States; by Dr. Edward Channing, on his index of maps bearing on our early history; by President White, on "The Development of the Modern Cometary Theory"; by General Cullum, on the disposal of Burgoyne's troops after the Saratoga Convention of 1777; by the Hon. Eugene Schuyler, on "Materials for American History in Foreign Archives." The reading of several of these papers was followed by interesting discussions. Davis R. Duvey made a report on a proposed "History of American Political Economy," which had been undertaken by Dr. Ely, Mr. Woodson Wilson, and himself. An historical map of Pennsylvania, by Mr. P. W. Sheafer, was exhibited and described. The Association recommended the organization of local historical societies, and the careful collection and preservation by them of everything which is or may become of historical interest, or a source of historical knowledge; it passed a testimonial resolution in honor of Leopold von Ranke, whom it elected its first honorary member; and it suggested to the Government the advisability of cataloguing all documents relating to the history of the United States down to 1800, existing in the official and private archives of Europe, and of copying and printing the most important of them.

The Grammar-School Reader. A Monthly Magazine. Vol. I, No. 1. Chicago and Boston: Interstate Publishing Company. Pp. 48. Price, 15 cents; $1 a year.

This is the highest of a series of three monthly readers which the Interstate Publishing Company have projected. The other readers of the series are the Primary, twenty cents a year, and the Intermediate, thirty cents a year. The present number is filled with lively articles and stories. In the department, "Ways to do Things," is an illustrated paper on "Knots, Hitches, and Splices," which the young constituency of the "Readers" might turn to practical advantage.

The Hygiene of Nature; or, Natural Selection and Immunity from Disease. By Dr. Romaine J. Curtiss. Joliet, Ill. Pp. 18.

An argument to show that Nature removes epidemics and such diseases as work great destruction for a course of years and then nearly disappear, by her own processes, constituting a natural selection, while sanitation is not entitled to the credit it claims for the extinction of such disorders. Applying his doctrine to the history of the epidemics of the middle ages, and to the shortness of life during that epoch, Dr. Curtiss says: "We find that when an epidemic prevailed it destroyed everybody who had not sufficient vital resistance. . . . Those who could sufficiently resist the disease, or who could acquire a resistance, lived and bequeathed the resistance to their children. In time, by this process, each generation acquired more and more resistance to each of the epidemics, and in time there was nothing left for the parasites of the great European epidemics to do except to acknowledge the survival of the fittest, whose name is Man." This immunity may be lost by atavism; and, when so lost, there will be a liability to the recurrence of great epidemics.

Easy Lessons in French. According to the Cumulative Method. By Adolph Dreyspring. New York: D. Appleton & Co. Pp. 142. Price, 70 cents.

We have already expressed appreciation of the merits of Professor Dreyspring's "Cumulative Method" in German, and of the happy application which—so far as books can go—he has made of it. With that application living in the schools, it was, as the author well says, a foregone conclusion that the system should in time be adapted to the acquisition of the French language. The present book represents the first step in such adaptation. The distinctive features of the method are presentation of the normal phases of the language first; selection of its elementary material, with special reference to what is usually in sight; development of the first needs of speech, as manifested by the simplest ordinary inquiries; unfolding the language out of itself; a vocabulary within reasonable bounds; a constant revolving of the accumulating material under ever varied forms and new combinations; and special care to interest the student and to preserve his enthusiasm for the study. The author maintains that his method is a decided revolt from the old practices, and that, as an initiatory step, it strenuously avoids the declensional and verbal pabulum usually administered to students. It opens its attacks upon points in the language offering the least resistance, such as nouns, adjectives, and prepositions, with the connective *is*; and it gives the preference to the descriptive power of speech over the volitive. Illustrations are given as aids to the lessons, and to make them more attractive and impressive. In the use of the work, the author insists on repetition, distinct and loud reading, and faithful practice of the verb-drill; when, he believes, its merits will not fail to be recognized.

The Three Systems of Life Insurance. By Mervin Tabor. Chicago: Bureau of Life-Insurance Information. Pp. 236. Price, $2.

The author of this book is Actuary of the Insurance Department of Illinois, and Manager of the Bureau of Life-Insurance Information. He has written it, he says, for the general public and for life-insurance agents and solicitors; and upon the suggestion of many letters which have been received at the Bureau, asking for information in a wide range of inquiry upon subjects involving the elementary principles of life insurance. The "three systems" mentioned in the title are designated as "The Level Premium," "The Natural Premium," and "The

Assessment" systems, each of them having advantages peculiar to itself, and being adapted to the wants of different classes of insured. The merits and workings of each are explained in detail, and their especial adaptations are elucidated. Besides the matter bearing immediately upon these points and also upon endowment, tontine, and semi-tontine insurance, the book contains the two leading mortality tables in use in this country; definitions and explanations, with illustrative examples, of the technical terms and expressions often used by agents and solicitors; articles on the failures of life-insurance companies, and their expenses in comparison with those of fire-insurance and railroad companies; interest and discount tables; an explanation of the construction of mortality tables; an article on the law of mortality and the wonderful precision with which it operates; and much other matter appropriate to the general subject of the book.

A Directory of Authors, including Writers for the Literary Magazines. Compiled by W. M. Griswold. Bangor, Maine: Office of the "Monthly Index." Pp. 16. Price, 50 cents.

This edition contains the additions and emendations to the list of authors published in the first edition of the Directory. Five hundred and ninety-six names of authors are enrolled, only the names of many of them being given, the accounts of whom can be found in the former edition. The compiler acknowledges that his Directory is incomplete—it is not within human possibilities to give such a work an approach to perfection till after many repeated efforts. He depends upon the authors themselves to remedy its defects, by furnishing him answers to the inquiries which he has sent out in his circular.

A New Philosophy of the Sun. By Henry Raymond Rogers, M. D. Dunkirk, N. Y. Pp. 27.

This is the substance of a paper which was read before the Chautauqua Society of History and Natural Science. It presents a theory that the sun is not hot or brilliant, but is simply a propagator of force—presumably electric force—the working of which in our atmosphere produces the calorific and luminous manifestations commonly regarded as solar.

A Navajo Skull, with an Additional Note on the same. By Professor Sir William Turner. Pp. 4, with Plate, and 2; Osteology of Conurus Caroliniensis. Pp. 16, with Plate. By R. W. Shufeldt, M. D.

The first and second of these monographs relate to the examination of the skull of a Navajo Indian of about forty years of age, who came to his death by a gun-shot wound of the head. The third paper is an investigation of the bony structure of the Carolina parrot.

PUBLICATIONS RECEIVED.

Garrison, F. Lynwood, Philadelphia. The Microscopic Structure of Car-Wheel Iron, pp. 7. The Microscopic Structure of Iron and Steel, pp. 12.

Martin, Lillie J., Indianapolis, Ind. Chemistry in the High-Schools. Pp. 12.

Hale, Horatio. The Origin of Languages, and the Antiquity of Speaking Man. Pp. 48.

Jastrow, Joseph, Johns Hopkins University. The Perception of Space by Disparate Senses. Pp. 16.

Bell, Clark. Report on Classification of Mental Diseases. Pp. 14.

Packard, S. W., Chicago. Review of the Anti-Saloon Republican Convention. Pp. 16.

Crothers, T. D., Hartford, Conn. Temperance, Parties, and Politics. Pp. 3.

Peabody Museum of American Archæology and Ethnology. Eighteenth and Nineteenth Annual Reports of the Trustees. Cambridge, Mass. Pp. 125.

Agricultural College of Michigan. Notes on Tomatoes. Pp. 15.

Levermore, Charles H. The Town and City Government of New Haven. Baltimore: N. Murray. Pp. 103. 50 cents.

Munroe, Charles E. Index to the Literature of Explosives. Part I. Baltimore: Isaac Friedenwald. Pp. 42. 50 cents.

Dulles, Charles W., M. D. The Mechanism of Indirect Fractures of the Skull. Philadelphia: P. Blakiston, Son & Co. Pp. 55, with Plates.

Smith, Eugene A., Ph. D., State Geologist. Geological Survey of Alabama. Bulletin No. 1. Pp. 86, with Nine Plates.

Commissioners of Fisheries, State of New York. Fourteenth Report. Albany: Weed, Parsons & Co. Pp. 209.

Sechrist, S. P. Sechrist's Hand-Book and Railway Equipment and Mileage Guide. Monthly. Cleveland, Ohio: J. B. Savage. Pp. 190.

Bell, Alexander Melville. English Line Writing (Phonetic). New York: Edward S. Werner. Pp. 52. 60 cents.

Stephenson, F. B., M. D. Arabic and Hebrew in Anatomy. Pp. 10. Sydenham and Hahnemann. Pp 6.

Stowell, T. B. The Vagus Nerve in the Domestic Cat, pp. 16. The Trigeminus Nerve in the Domestic Cat, pp. 20.

Commissioner of Pensions. Annual Report, to June 30, 1886. Washington: Government Printing-Office. Pp. 70.

Grey, Maxwell. The Silence of Dean Maitland. New York: D. Appleton & Co. Pp. 372. 50 cents.

Holbrook, M. L., M. D. How to strengthen the Memory. New York: M. L. Holbrook & Co. Pp. 152. $1.

Wilson, George. A Hand-Book of Hygiene and Sanitary Science. Philadelphia: P. Blakiston, Son & Co. Pp. 520. $2.75.

United States National Museum. Proceedings. Vol. VIII, 1885. Washington: Government Printing-Office. Pp. 729, with Plates.

Smithsonian Institution. Report of the Board of Regents for 1884. Washington: Government Printing-Office. Part II. Pp. 458.

McLennan, the late John Ferguson. Studies in Ancient History. New York: Macmillan & Co. Pp. 387. $4.

Ayer, N. W. and Son. American Newspaper Annual. 1886. Philadelphia: N. W. Ayer & Son. Pp. 1010. $3.

Brown, Walter Lee. Manual of Assaying Gold, Silver, Copper, and Lead Ores. Chicago: E. H. Sargent & Co. Pp. 487. $2.50.

Rosenkranz, Johann Karl Friedrich. The Philosophy of Education. New York: D. Appleton & Co. Pp. 286. $1.50.

Mallock, W. H. The Old Order changes. New York: G. P. Putnam's Sons. Pp. 513. $1.

Anders, J. M., M. D. House-Plants as Sanitary Agents. Philadelphia: J. B. Lippincott Company. Pp. 334. $1.50.

Owen, Catherine. Ten Dollars Enough. Boston and New York: Houghton, Mifflin & Co. Pp. 279. $1.

Bert, Paul. First Series in Scientific Knowledge. Philadelphia: J. B. Lippincott Company. Pp. 370. 60 cents.

Johnson, J. B., C. E. The Theory and Practice of Surveying. New York: John Wiley & Sons. Pp. 683.

Bancroft, Hubert Howe. History of the Pacific States of North America. Vol. XXIV. Oregon. Vol. I. 1834–1848. San Francisco: The History Company. Pp. 789.

Gore, J. Howard. Elements of Geodesy. New York: John Wiley & Sons. Pp. 282.

Reed, Lieutenant Henry A. Topographical Drawing and Sketching, including Applications of Photography. New York: John Wiley & Sons. Pp. 129, with Plates. $3.50.

POPULAR MISCELLANY.

The State and Public Health.—Professor Edward Orton, in an address before the Ohio State Medical Society, on "The Relation of the State to the Health of the People," asserts that "the manner in which we are doing much of our sanitary work is far below the best knowledge of our time, and is a serious reproach upon our civilization. We are expending enough, and more than enough, to give us ample protection from the diseases which threaten us, but our ill-devised plans and our worse-constructed work leave us still, to a large degree, within their power." There is much truth in this, and the reason for it is perhaps to be found in the fact that too much is done for the sake of doing, without taking sufficient pains to do intelligently. Professor Orton would remedy the evil by putting all local sanitary work under the control of municipal boards of health, "which should be measurably permanent bodies, and which should be intrusted with large powers." The quality of permanence should be insisted upon, that the boards may profit by their mistakes, and learn as they go, and not, being renewed every little while, go on repeating the mistakes of their predecessors or blundering into new ones. Then Professor Orton would have the work of these local boards unified under a State Board—an important matter, in consideration of the extensive geographical fields that often come under common sanitary relations. Such general supervision is particularly called for in a State situated as Ohio is, which, through most of its area at least, must depend for the future, as it does in the present, upon its rivers and lakes for its water-supply; and the question of guarding these sources becomes one of the gravest importance, which a State Board or its equivalent only is competent to deal with.

Bacterial Products as Antidotes for Bacteria.—D. E. Salmon communicated to the American Association the results of experiments which he had made in neutralizing the pathic effects of bacteria by means of the chemical products of bacterial action. They had been made upon pigeons with the bacteria of the swine-plague virus and their products. Since the demonstration of the germ theory of disease, it has become evident that there are three possible explanations of the action of these products: 1. Something is deposited in the body during the attack of disease that is unfavorable to the specific germ. 2. Something is exhausted which is essential to the development of the germ. 3. The living tissues acquire such a tolerance for the germ, or for a poison which it produces, that they are no longer affected by it. If either the first or the third of these explanations is correct, it would appear possible that immunity might be gained by introducing into the tissues the liquids in which the specific germs have been cultivated, and from which they had been removed by filtration, or in which they have been killed by suitable methods. The speaker had long been convinced of the correctness of this supposition, but it was only recently that he had been able to make a satisfactory demonstration of the principle.

Visions of the Blind.—Mr. J. Jastrow had an interesting paper, at the American Association, on "The Dreams of the Blind." Vision in dreams is connected with a recollection of sight, and the fact of its manifestation would mean that in the dreamer's brain there is developed a sight-center, the spontaneous activity of which is the material substratum of his dreams. Brain-centers, we know from observation and experiments on animals, are of slow growth. By asking what is the latest age at which a child may become totally blind and still retain dream-vision, we will be asking how long a time is necessary for the sight-center to develop, and sufficiently to enable it to function without further retinal stimulation. "Two hundred blind persons (mostly young) in the institutions for the blind at Baltimore and Philadelphia, were questioned in detail in regard to their dreams, and from their answers I conclude that the critical age is between the fifth and the seventh year. Those losing their sight before this age have no more vision in their dreams than if they were blind from birth. Those who become blind during this period may or may not lose dream-vision; while those whose eyesight is destroyed after this period find themselves quite on a par with seeing persons in dream-life. Only cases of total blindness are employed as a basis for this conclusion. With regard to cases of partial blindness it is found that the same period divides those whose dream-vision is brighter and more vivid than the partial sight of waking life from those whose waking life furnishes, though filled with imperfect sensations of sight, the material for dream-images."

The Cause of the Charleston Earthquake.—The theories of the causes of earthquakes are almost as various as the phenomena themselves; and it is the general opinion of those who have most carefully studied the subject that no single cause is competent to account for all that occur. The most evident fact about the cause of the recent shocks by which Charleston has been afflicted is, that there is nothing volcanic about it. Otherwise, our geologists incline to the belief that they are the concomitant of a line of weakness extending near the Atlantic coast from about Troy, New York, by Baltimore, Washington, and Richmond, to the Carolinas, and that the phenomena were immediately the result of a renewed faulting or displacement in the latter region. Tidal action may have had something to do with it; and notice has been taken of the fact that at the time of the severe shock at Charleston, the moon had been new, at perigee only about sixty hours, or a fair time for the accumulation of the effect, previous to its occurrence. The fact particularly illustrates Perrey's theory of tides of the fluid interior of the earth. How little, however, is really known about the causes of this or of any other earthquake is somewhat amusingly illustrated by a remark of Professor Dawson's the day after he had delivered his address as President of the British Association, and after the news had reached him of the disaster in Charleston. "The phenomena of the present earthquake convulsions in America and elsewhere, but particularly in America," he said, "are extremely puzzling, and completely upset some of the conclusions set forth in the address I read last evening." The Geological Survey has sent out a circular asking from observers as definite statements as they can obtain respecting the details of the phenomena. The questions have reference to the perceptible occurrence of the shock; its exact hour, minute, and second in standard time; the duration of the shocks; the accompanying noise, if any; the number, etc., of the shocks; the measure of intensity—whether very light, light, moderate, strong, or severe; the possibility of the existence of any other cause for what happened than an earthquake; and whatever other particulars of interest may have been noticed or learned by hearsay.

Mr. Darwin on Geologic Time.—Mr. G. H. Darwin, President of the Geological Section of the British Association, made a survey of the theories of geological time, including those of Mr. Croll and Sir William Thomson, and concluded from them that something has been acquired to our knowledge, but that much more remains still to be determined. It seems as likely that in this problem geology and meteorology will pass the word of command to physics as the converse. At present our knowledge of a definite limit to geological time has so little precision that we should do wrong to reject summarily any theories which appear to demand longer periods of time than those which now seem allowable. In each branch of science hypothesis forms the nucleus for the aggregation of observation, and as long as facts are assimilated and co-ordinated we ought to follow our theory. Thus, even if there be some inconsistencies with a neighboring science, we may be justified in still holding to a theory, in the hope that further knowledge may enable us to remove the difficulties. There is no criterion as to what degree of inconsistency should compel us to give up a theory, and it should be borne in mind that many views have been utterly condemned when later knowledge has only shown us that in them we were only seeing the truth from another side.

An Inventory of the Glacial Drift.— Vice-President Chamberlin, in his address before the American Association's section of Geology and Geography, presented "An Inventory of our Glacial Drift." Having described the boundaries of the drift as represented on a wall-map, the speaker remarked that a wealth of significance lay in the sinuosities, vertical undulations, and varying characters of the southern border. It undulates over the face of the land essentially much as an arbitrary line from New York Harbor to Puget Sound, and could be reduced to horizontality—as it must have been to have marked the margin of some ancient ice-bearing body of water—only by incredible warpings and dislocations. The border presents three notable phases: one part terminating in a thickened belt, a terminal moraine; another in a thin margin; and a third in an attenuated border of scattered pebbles. The morainic border prevails in the Atlantic region and on or near the limit as far west as Central Ohio. Throughout the rest of the stretch to the Rocky Mountains the attenuated edges prevail. Of unstratified bowldery clays or tills, there is the richest variety, ranging through diverse combinations of material, texture, and aggregation. Of moraines, terminal, lateral, medial, and intermediate varieties are found. The great terminal moraines overshadow all others in interest and importance. Outside of the chief moraines are occasional belts of older drift aggregated in the similitude of peripheral moraines. Back from the two principal terminal moraines lie similar partially determined belts, usually of less prominence and continuity. Our most unique moraines are the interlobate, developed between the tongues into which the ice-sheet of the second epoch was divided at its margin, of which about a dozen, in half as many States, are recognized. Beautiful lateral moraines abound in the mountainous regions of the West, and some were developed by local glaciation supervening upon the ice retreat of the East. Our medial moraines are unimportant, and confined essentially to mountainous glaciation. Allied to the true moraines are special forms of aggregation of the sub-glacial *débris*. Two classes commonly embraced in the assorted drifts should be excluded from them: the "orange sands" of the Mississippi Valley, which do not appear to possess the distinctive characteristics of glacial gravels, but are residuary in aspect; and the secondary drifts, or those that have been reworked by wholly non-glacial agencies. Eliminating these, two classes of products of glacial waters working co-ordinately with the ice are recognized: those that gathered immediately within and beneath the ice-body itself, or against its margin; and those which were borne to distances beyond its limit by the glacial drainage or by peripheral waters. The products embrace a great variety of sub-types of gravel-heapings, including isolated mounds, conical peaks, clustered hummocks with inclosed pits and basins, and sharp, steep-sided ridges, often of phenomenal length, all possessing great irregularities of material and stratification, embracing frequently, manifest disturbances. The elongated variety, resembling the great *osars* of Sweden, are finely developed in Eastern New England; while the hummocky variety, constituting the ill-defined class of kames, are abundant throughout New England, New York, Northern New Jersey, Pennsylvania, Ohio, Indiana, the greater part of Michigan, Northern Illinois, Eastern and Northern Wisconsin, Northern Minnesota, North-Central Iowa, Eastern Dakota, and many parts of Canada. Of valley drift, attention was directed to the moraine-headed valley trains, and the loess tracts. The former show progressively coarser material toward their origin, and merge into expanded heads, blending with the moraines in which they begin. The broad tracts of fine silt, designated "loess," occupy the Mississippi up to East-Central Minnesota, the Missouri up to Southern Dakota, the Illinois and Wabash up to their great bends, and the Ohio up to Southeastern Indiana. Two other assorted deposits considered were those overspreading the great basin of the St. Lawrence and the Winnipeg basin. These often present, among their surest credentials, overflow channels to the southward, crossing divides sometimes hundreds of feet above existing outlets, and varying in altitude among themselves at least two thousand feet.

Durability of Water-Color Drawings.— A controversy, which recently arose in England on the durability of water-color drawings, led to an exhibition of pictures at which visitors were given opportunity to test for themselves the capacity of the specimens shown to hold their colors. The "Saturday Review" draws from the average of the works the conclusions that, in pictures or passages of especially vivid color, little in the way of fading need be apprehended; but, in the delicate, broad, and thin washes of the landscape-painter, "changes of various kinds are apt to take place, capriciously, as it would seem, and from various causes, of which long and continued exposure to light is probably one. Pending more accurate experiments, collectors and managers of public institutions will do well to keep their framed drawings rigorously protected from pure sunlight, and not exposed more constantly than is necessary to ordinary daylight; for which purpose they should be covered with blinds or curtains during the long hours of the summer mornings, and generally when the rooms in which they are hung are disused. Also it will probably be well to vary from time to time the drawings exhibited, and to return each occasionally for a period of rest to the drawer or cabinet. But on the question of frames *versus* portfolios, it has to be remembered that a well-framed drawing is secure at least from effects of atmosphere; while in portfolios it is only by extreme and constant care that risks can be avoided from dust and rubbing."

Marine Signals.—Sir James Douglass addressed the Section of Mechanical Science of the British Association on lighthouses and marine signals. There are at present not less than eighty-six distinctive characters in use throughout the lighthouses and light-vessels of the world; and as their numbers increase so does the necessity for giving a more clearly distinctive character to each light over certain definite ranges of coast. This important question of affording to each light complete distinctive individuality is receiving the attention of lighthouse authorities at home and abroad, and it is hoped that greater uniformity and consequent benefit to the mariner will result. There are now about seven hundred fog-signals, of various descriptions, on the coasts of the world; and their construction and operation have been the subject of careful experiment and scientific research. Unfortunately, the results thus far have not been so satisfactory as could be desired. This is owing partly to the very short range of the most powerful of the signals under occasional unfavorable conditions of the atmosphere during fog, and partly to the present want of reliable tests for enabling the mariner to determine at any time how far the atmospheric conditions are against him in listening for the signal. The question of utilizing lighthouses and light-vessels as signal-stations in telegraphic communication with each other and with a central station, has received the consideration of lighthouse authorities generally, and has been made of practical effect in Canada. Buoys are illuminated with compressed oil-gas; and automatic lighting apparatus has been applied to those in occasionally inaccessible positions. A comparative test of the merits of electricity, gas, and mineral oil, as lighthouse illuminants, carried on for twelve months, has given the following results: 1. That the oil- and gas-lights, when shown through similar lenses, were equally affected by atmospheric variation; 2. That the electric light is absorbed more largely by haze and fog than either the oil- or the gas-light; and, 3. That all three are nearly equally affected by rain. The final conclusions of the committee are that for ordinary necessities of lighthouse illumination mineral oil is the most simple and economical illuminant; and that for salient headlands, important land-falls, and places where a very powerful light is required, electricity offers the greatest advantages.

Heredity and Education.—"Heredity and Education; their Relation to Each Other and to the Human Race," is the title of an address by Dr. E. A. Wood, as President of the Pennsylvania Medical Society. The author holds very positive views on the subject, both as to the excellence to which he would have us aim to bring the race, and with regard to the means to be used to reach the end. "If such a man as Shakespeare," he asks, "has lived, why may not men as great as he live again; and if one man attained this greatness, why may not the average man? If the old Greeks reached such perfect development, why may not Americans? Is it possible that we have reached the zenith of our possibilities? Is it not rather probable that Shakespeare approximated but did not attain the possible average of human development? . . . Nature has written all over her page that Newton and Shakespeare were not accidents, but advance heralds, proclaiming the coming man. No man can conceive of the latent potentiality of the human race; by right effort continued in the right direction, man may be developed into a being grander than his loftiest ideals." Further: "Let it be written that many races of men have improved, are improving, and bid fair still further to improve; but man has not improved in accord with his powers and opportunities, has not reached the standard of excellence reached two thousand years ago, and is not improving so rapidly as are the animals domesticated by him. The first step toward race improvement must be to teach our children that reproduction is the highest and noblest function of the animal. We are losing time by not teaching this lesson, and all implied by it, immediately and thoroughly."

The Future of the Supply of Plant-Food.—Vice-President Wiley began his address before the Chemical Section of the American Association—which was on "The Economical Aspect of Agricultural Chemistry"—with a rough estimate of the money value of the potash, phosphoric acid, and nitrogen contained in a single harvest, the total of which he placed at $3,343,786,050. This seems to be an enormous quantity of plant-food to be removed from the soil annually, but it must be remembered that it is not all lost; much of it is left in the soil in roots, straw, stalks, etc. But too often the *débris* is got rid of as quickly as possible, and we have in practice not tilling but killing the soil. The stores of plant-food which have accumulated in our virgin soils are indeed great, but they can not withstand this constant drain upon them. The potash that is in the soil may be estimated as enough to last two hundred and fifty years, and the phosphoric acid two hundred and twenty-five years. Immense reserves of both substances are, however, existent and accessible—the potash in feldspathic rocks, and phosphorus in the phosphate-beds. Still, the exportation of agricultural products becomes a slow but certain method of securing soil exhaustion. In point of fact, however, Professor Wiley further showed, the impoverishment of the soil takes place at a much slower rate than the theory announced above would indicate. Doubtless, much reserve food is brought from the subsoil, and, if it be possible for the subterranean stores of these materials to gradually work their way surface-ward, even the remote future need not fear a dearth of them. There is also a certain conservatism in crops, a vegetable "good breeding," which prevents the growing plant from taking all the food in sight. As long as there is abundance, the plant is a hearty eater; but, when the visible quantity of food falls to a certain minimum, it remains for a long time without any rapid diminution. Respecting the nitrogenous food of plants, Professor Wiley presented a series of studies from which the following conclusions were drawn: 1. The combined nitrogen, which is the product of vegetable and organic life, forms the chief source of nitrogen for the growing plant. 2. Before it is assimilated by the plant, it undergoes a process of oxidation which is due solely to a living organism. 3. The nitrates thus formed are absorbed by the plant, and the albuminoids of the new growth are formed from the nitric nitrogen by a process of reduction. The nitrates themselves are subject to the action of a ferment by which a deoxidation takes place, and free nitrogen and nitrous oxide are evolved. 4. The diminution in the quantity of available nitrogen thus supplied is restored by the fixation of free nitrogen, by the action of organisms in the soil, or by the oxidation of free nitrogen by the interior cells of the plant acting in a manner analogous to the nitric ferment in the soil, or by the oxidation of free nitrogen by electrical discharges or by combustion. 5. The quantity of combined nitrogen brought to the soil and growing plant by the rain-water and the atmosphere, arising from the last two phenomena, is an inconsiderable amount when compared with the whole weight required by the crop. Concerning the future food-supply, Professor Wiley said: "Since, with a proper economy, the natural supplies of potash and phosphoric acid may be made to do duty over and over again, and last indefinitely, the economist, who looks to the welfare of the future, need have no fear of the failure of these resources of the growing plant. Indeed, it may be said that the available quantities of these may be increased by a wide practice of agriculture based on the teachings of agricultural chemistry. But with the increase of population comes an increased demand for food, and therefore the stores of available nitrogen must be enlarged to supply the demands of the increased agricultural product. It is certain that with the new analytical methods, and the question raised by the investigations, many series of experiments will be undertaken, the outcome of which will definitely settle the question of the entrance of free nitrogen into vegetable tissues. If this question be answered affirmatively, agricultural science will not place bounds to the possible production of foods. If the nitrifying process goes on within the cells of plants, and if living organisms do fix free nitrogen on the soil in a form in which at least a portion of it may be nitrified, we may look to see the quantities of combined nitrogen increased *pari passu* with the needs of plant-life. Thus, even intensive culture may leave the gardens and spread over the fields, and the quantities of food suitable for the sustenance of the human race be enormously increased."

Evolution of Means of Defense.—Mr. Charles Morris, in a paper of the Academy of Natural Sciences of Philadelphia, on "Attack and Defense as Agents in Evolution," suggests that the various modifications which are seen in the hard parts of animals at different periods indicate adaptation to dominant ideas that have different relations to the prevailing conditions of existence of the time. The earliest animals were probably wholly soft, and have left no remains except an occasional track on the mud of their day. Then came in armored forms with external shells. Swift-swimming armored animals came in with the fishes, and seem to have increased in thickness and weight of armor to the end of the Devonian era. "If, now, we come down to a later era of life, we find in operation what seems a third idea of Nature. The prevailing tendency in animal life is no longer to assume armor, but to throw off armor, and return toward the unprotected condition. The causes of these changes are related to the development of weapons of assault in attacking animals, and to the kind of defense that was most available and useful, or most efficient at the period. As Mr. Morris says: "In the primeval epoch it is probable that only soft-bodied animals existed, and the weapons of assault were the tentacles, the thread-cell, the sucking-disk, and the like unindurated weapons. At a later period armor became generally adapted for defense, and the tooth became the most efficient weapon of attack. Still later, armor was discarded, and flight or concealment became the main method of escape, and swift pursuit the principle of attack, while claws were added to teeth as assailing weapons. Finally, mentality came into play, intelligence became the most efficient agent both in attack and defense, and a special development of the mind began. As a culmination of the whole, we have man, in whom mentality has replaced all other agents in the struggle for existence. But, side by side with man all the other types exist, the soft-bodied, the armored, the swift-moving, and those in which cunning precedes the higher mentality. In the existing conditions of life upon the earth we have an epitome of the whole long course of evolution."

Acclimatization of Deer. — Viscount Powerscourt has communicated to the Zoölogical Society of London the results of his experiments in acclimatization, conducted since 1858 and 1859, on his estate in Ireland, of foreign deer. He had at one time alive in a park of one hundred acres, about two thirds of which was open pasture and one third wood, red deer, Sambur deer, Nylghaies, axis deer, llamas, elands, wapiti deer, and moufflons, or wild sheep. The red deer increased and the wapiti bred, but the Nylghaies died while still apparently in good health. Accidents interfered with the success of the experiments with the wapitis, but the results, taken in connection with experiments made elsewhere, indicated that the acclimatization of these deer will be entirely practicable. The Samburs declined, and died in the course of three or four years, because, apparently, they insisted on staying in the shade. The elands, axis, and llamas died, or proved so delicate that they had to be taken away. The most favorable results were obtained with Japanese deer (*Cervus sika*), which throve excellently and multiplied without requiring other than the ordinary winter feeding. They are pronounced, after twenty-four years of breeding and increase, "a most satisfactory little deer; the venison when dressed is about the size of a Welsh mutton, and well flavored."

Longevity of Great Men.—In a paper read at the American Association, on "The Longevity of Great Men," Mr. J. Jastrow observed that all that the usual method of attempting to answer the question whether great men are longer lived than others can prove is that it takes long to become great. It neglects to consider that a select class of men is dealt with, and that to become potentially included in this class one must have lived a certain number of years. A review of a list of greatest men appeared to show that, on the average, a man must be thirty-seven years old in order to be a candidate for a place in this list. Comparing the ages to which such men live with the average expectation of life of men at thirty-seven, the author inferred that men of thought live three years longer, while the lives of men of feeling are three years, and those of men of action five years shorter than those of ordinary men—a conclusion which is somewhat different from the commonly accepted view on the subject. The question of longevity becomes important when we consider that through it the leaders of thought are allowed to exercise their important function here a few years longer, so that more great men are enabled to be alive at the same time. By the rule of heredity also, the children of great men will begin life with a better chance of reaching maturity and an age when they may become important to the world.

Evils of Undiscriminating Charity.—It is asserted by a clergyman residing in one of the districts where the most good was attempted to be done by its distribution, that the Mansion House charitable fund of London has done a vast amount of mischief in those very districts. This clergyman, Mr. Barnett, Vicar of St. Jude's, treats the fund as a calamity which has befallen London, not less, perhaps even greater, than the distress for which it was supposed to be the remedy. The evil arises from the failure to exercise discrimination in the administration of a bounty which, properly applied to the proper persons, might be made of great benefit. The failure in this case to accomplish an object designed to be good leads the "Spectator" to indulge in some remarks on the mischievousness of undiscriminating good feeling in general. There is hardly a single good feeling, it says, however just and praiseworthy in its kind, which men can simply indulge without incurring the greatest danger of doing harm. There is, for instance, the lavish habit of bestowing praise and blame in unmeasured volume, under the dictation of mere impulse. "We see men and movements praised up to the skies which are full of dubious elements, half evil and half good, and other men and other movements as passionately censured which, again, are full of the same double character, half good and half evil. . . . The result undoubtedly is, that we give sympathy in the gross where only discriminating sympathy would be beneficial, and blame in the gross where only discriminating blame would be beneficial. And, as a natural consequence, we hatch all sorts of unhealthy eagerness to do what either ought not to be done at all, or else ought not to be done except by very carefully selected people, and all sorts of equally unhealthy eagerness to run down modes of action which in the right hands may be wise and good, though in the wrong hands they are pernicious in the highest degree."

NOTES.

Mr. A. H. Allen, in a paper on oils, read in the American Association, said that shark and fish oils are often unsaponifiable, and hence are not fatty ethers. He believed them to contain cholesterine, like cod-liver oil. The fixed oils can be separated into groups, but we know no process for separating a mixture of lard and cotton-seed oil.

Professor A. R. Leeds reported to the Chemical Section of the American Association that his most careful analyses had given as the composition of human milk: albuminoids, varying from ·5 to 4·25 per cent; lactose, from 4·1 to 7·8 per cent; and fat, from 1·7 to 7·6 per cent. The appearance and specific gravity of the milk, he said, never indicate its composition.

M. Fayal has come to the conclusion that the rise in temperature to which the spontaneous combustion of coal-dust is due, is produced by the absorption of atmospheric oxygen. He finds that lignite is ignited at 300° C., anthracite at 500°, and other varieties of coal, in powdered form, at intermediate temperatures.

Dr. Börsch reported last year to the Meteorological Society at Berlin that three observers, working respectively at Berlin, Breslau, and Königsberg, to determine the differences of longitude between the three cities, noticed at the same moment abnormal deviations in the air-bubbles of their levels, which could be attributed to nothing else than movements of the ground. They afterward learned that some of the central parts of the Asiatic continent had at that very time been shaken with violent earthquakes. The supposition that the deviations noticed were connected with these shocks was confirmed by the fact that they were more marked at the eastward stations.

For the many millions of dollars that have been expended upon astronomy during the past two or three centuries, results have been obtained, says Professor E. C. Pickering, of Harvard College Observatory, whose value it is impossible to estimate. Apart from the knowledge it has given us of other worlds and of the laws governing the universe, it has furnished us information regarding this world which has been of enormous practical importance. It has secured safe and certain communication between distant countries, accurate maps, and the precise determination of time. The pecuniary value of these results would many times repay the total expenditure made for astronomical purposes.

A new edition of Professor Ferrier's "Functions of the Brain" is announced. The book has been nearly rewritten, and will include the results of new investigations by the author, and of investigations made by others during the last ten years.

The Rev. George Brown, missionary in the New Britain Islands, read a paper in the British Association in which he said that the results of fourteen and a half years of labor in Samoa among Polynesians, and in New Britain among Papuans, in reducing the languages and studying the manners and customs of the people, had convinced him that the Polynesian race was descended from the great Papuan stock with an Asiatic admixture. Mr. Fellows remarked upon this that if they went back far enough, a common origin would be found for all people. It was, therefore, desirable that some time of common origin should be fixed.

Mr. R. Warrington reported to the British Association that the results of his later experiments at Rothampstead showed a far deeper diffusion of the nitrifying organism in the soil than had been concluded from the earlier experiments. The power of producing nitrification was now found to exist generally down to three feet from the surface. Below this point the occurrence of the organism became less frequent, though at five and six feet about half the trials resulted in nitrification; with soil from seven and eight feet no nitrification was obtained. The considerable difference between the earlier and later results was to be attributed to the employment of gypsum in the later solutions.

The Marquis of Lorne, in his presidential address before the Royal Geographical Society, cited, in illustration of the rapidity with which Africa is being opened up, the journey of Mr. Thomson to the capitals of Sokoto and Gando, the two great negro kingdoms of the Central Soudan. In four months from the date of his leaving Liverpool, Mr. Thomson, proceeding by way of the Niger, reached the capital of Sokoto with a party of one hundred and twenty West Coast negroes. He then negotiated a treaty of great commercial and political importance, and three months later was again in England, the whole journey having only occupied seven months. Twenty years earlier, it would probably not have been made in less than double that time.

M. Pradanovic, of Pesth, has devised a way of driving stakes by means of dynamite. He puts a plate of iron about four inches thick on the top of the stake, and on this he places his charge of dynamite. With a single cartridge, containing fifty-five grains of dynamite, he obtains five times as much force as with the average pile-driver. One of his iron plates is good for about twenty-five explosions.

Sir William Dawson observed in the British Association that as the result of his studies of the footprints of a species of limulus, it appeared that a number of impressions—protichnites and climactichnites—and supposed fossil fucoids, may be really tracks of crustaceans, and probably of trilobites and limuloids.

The British Association passed a resolution expressing its solicitude that the exposed mummies of the Egyptian kings be carefully preserved against decay; and requested the owner of Stonehenge to take measures to secure that remarkable antiquity against dilapidation.

The British Association received two invitations to visit Australia, or send a deputation there—one to Sydney, to assist in the celebration of the centennial of the first settlement of New South Wales, and the other to Melbourne. The General Committee decided to depute a number of representative members to attend the meeting of the Australian Associations in that year. The meeting for 1888 was appointed to be held in Bath. Sir Henry Roscoe was appointed to be the president of the meeting for 1887, which is to be held in Manchester.

The British Government has decided to authorize the growing and curing of tobacco in the United Kingdom. In Europe, generally, the cultivation of this plant has greatly decreased during recent years. The acreage in the Netherlands is at present not more than about half what it was ten or twelve years ago. The decrease has been considerable, but not to so great an extent, in Belgium. In Austro-Hungary 8,768 acres less were under cultivation in 1884 than two years before; in Germany, 12,000 acres less in 1883 than in 1881. In Italy, 8,202 acres, and in France, 32,800 acres, were grown last year. In America, on the other hand, the crop rose from 199,752,655 pounds in 1850, to 472,661,117 in 1880, for the growing of which 638,841 acres were required. The crop of 1883 was 451,545,641 pounds from 638,739 acres.

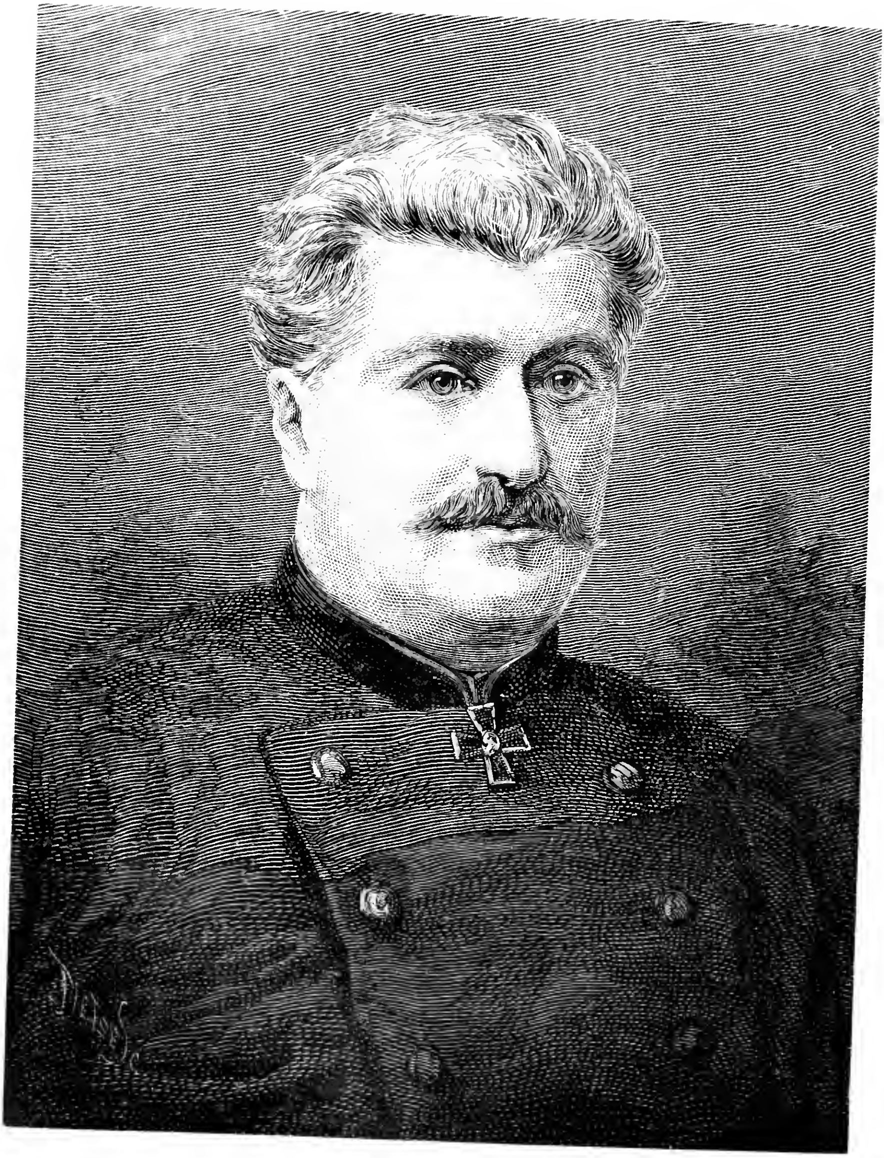
OBITUARY NOTES.

Maurice Girard, formerly Professor of Physics in the Collége Rollin, France, died in September. He was a naturalist of considerable merit, and an eminent entomologist; and was the author of a number of scientific and popular-scientific books, including a "Treatise on Entomology" and "The Metamorphoses of Insects" in the "Library of Wonders." He was connected with M. Tissandier's "La Nature" from its beginning.

Alexander Krapotkin, a man who has done some good work for science in Russia, died at Tomsk on the 6th of August, forty-five years of age. He translated Mr. Spencer's "Principles of Biology" and Clerk-Maxwell's "Theory of Heat" into Russian, and for several years contributed to Russian periodicals reviews of the progress of astronomy. In 1874 he was exiled to Minussinsk, in East Siberia, and there helped to organize a local museum, and carried on meteorological observations for several years. His most important work was a critical investigation of all our present knowledge of the stellar systems and the constitution of stellar groups, for which he made most thorough studies, but which he did not live to complete.

M. Paul Soleillet, an adventurous French African explorer, has recently died, at the age of forty-four years. He went to Algeria when twenty-five years old, and spent a large part of his life in explorations of the interior, particularly of the Sahara. He started on a journey to Abyssinia in 1883.

Dr. James G. Wakley, editor of the London "Lancet," died at his home near Chertsey, August 30th. He was the youngest son of the late Thomas Wakley, founder of the "Lancet," and had himself been editor of that journal since 1862.



NICHOLAS PREJEVALSKY.

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WHAT MAKES THE RICH RICHER AND THE POOR POORER.

By Professor WILLIAM G. SUMNER.

KARL MARX says, "An accumulation of wealth at one pole of society indicates an accumulation of misery and overwork at the other."* In this assertion, Marx avoids the very common and mischievous fallacy of confusing causes, consequences, and symptoms. He suggests that what is found at one pole indicates, or is a symptom of, what may be found at the other. In the development of his criticisms on political economy and the existing organization of society, however, Marx proceeds as if there were a relation of cause and effect in the proposition just quoted, and his followers and popularizers have assumed as an indisputable postulate that the wealth of some is a cause of the poverty of others. The question of priority or originality as between Marx, Rodbertus, and others, is at best one of vanity between them and their disciples,† but it is of great interest and importance to notice that the doctrine that wealth at one pole makes misery at the other is the correct logical form of the notion that progress and poverty are correlative. This doctrine rests upon another and still more fundamental one, which is not often formulated, but which can be detected in most of the current socialistic discussions, viz., that all the capital which is here now would be here under any laws or institutions about property, as if it were due to some independent cause, and that some have got ahead of others and seized upon the most of it, so that those who came later have not been able to get any. If this notion about the source of capital is not true, then wealth at one pole can not cause poverty at the other. If it is

* "Das Capital," i, 671.

† On this question see Anton Menger, "Das Recht auf den vollen Arbeitsertrag," Stuttgart, 1886. This writer traces back for a century the fundamental socialistic notions. He aims to develop the jural as distinguished from the economic aspect of socialism.

true, then we can make any regulations we like about the distribution of wealth, without fear lest the measures which we adopt may prevent any wealth from being produced.

In Rome, under the empire, wealth at one pole was a symptom of misery at the other, because Rome was not an industrial state. Its income came from plunder. The wealth had a source independent of the production of the society of Rome. That part of the booty which some got, others could not have. No such thing is true of an industrial society. The wealth of the commercial cities of Italy and Southern Germany, in the middle ages, was largely in the hands of merchant-princes. If one were told that some of these merchants were very rich, he would have no ground of inference that others in those cities must have been poor. The rich were those who developed the opportunities of commerce which were, in the first instance, open to all. What they gained came out of nothing which anybody else ever had or would have had. The fact that there are wealthy men in England, France, and the United States to-day, is no evidence that there must be poor men here. The riches of the rich are perfectly consistent with a high condition of wealth of all, down to the last. In fact, the aggregations of wealth, both while being made and after realization, develop and sustain the prosperity of all. The forward movement of a strong population, with abundance of land and highly developed command by machinery over the forces of Nature, must produce a state of society in which average and minimum comfort are high, while special aggregations may be enormous, misfortune and vice being left out of account.

Whatever nexus there is between wealth at one pole and poverty at the other can be found only by turning the proposition into its converse—misery at one pole makes wealth at the other. If the mass at one pole should, through any form of industrial vice, fali into misery, they would offer to the few wise an opportunity to become rich by taking advantage of them. They would offer a large supply of labor at low wages, a high demand for capital at high rates of interest, and a fierce demand for land at high rent.

It is often affirmed, and it is true, that competition tends to disperse society over a wide range of unequal conditions. Competition develops all powers that exist according to their measure and degree. The more intense competition is, the more thoroughly are all the forces developed. If, then, there is liberty, the results can not be equal; they must correspond to the forces. Liberty of development and equality of result are therefore diametrically opposed to each other. If a group of men start on equal conditions, and compete in a common enterprise, the results which they attain must differ according to inherited powers, early advantages of training, personal courage, energy, enterprise, perseverance, good sense, etc., etc. Since these things differ through a wide range, and since their combinations may vary through a wide range, it is possible that the results may vary through a wide scale of degrees. Moreover, the more intense the competition, the greater are the prizes of success and the heavier are the penalties of failure. This is illustrated in the competition of a large city as compared with that of a small one. Competition can no more be done away with than gravitation. Its incidence can be changed. We can adopt as a social policy, "Woe to the successful!" We can take the prizes away from the successful and give them to the unsuccessful. It seems clear that there would soon be no prizes at all, but that inference is not universally accepted. In any event, it is plain that we have not got rid of competition—i. e., of the struggle for existence and the competition of life. We have only decided that, if we can not all have equally, we will all have nothing.

Competition does not guarantee results corresponding with merit, because hereditary conditions and good and bad fortune are always intermingled with merit, but competition secures to merit all the chances it can enjoy under circumstances for which none of one's fellow-men are to blame.

Now, it seems to be believed that although competition produces wide grades of inequality, almsgiving, or forcible repartition of wealth, would not do so. Here we come to the real, great, and mischievous fallacy of the social philosophy which is in vogue. Whether there are great extremes of rich and poor in a society is a matter of very little importance. There is no ground for the importance which is attached to that fact in current discussion. It is constantly affirmed in one form or another that, although one man has, in half a lifetime, greatly improved his own position, and can put his children in a far better condition than that in which he started, nevertheless he has not got his fair share in the gains of civilization, because his neighbor, who started where he did, has become a millionaire. John, who is eating a beefsteak off iron-stone china, finds that the taste of it is spoiled because he knows that James is eating pheasants off gold. William, who would have to walk anyway, finds that his feet ache a great deal worse because he learns that Peter has got a horse. Henry, whose yacht is twenty feet long, is sure that there is something wrong in society because Jacob has one a hundred feet long. These are weaknesses of human nature which have always been the fair game of the satirists, but, in our day, they are made the basis of a new philosophy and of a redistribution of rights and of property. If the laws and institutions of the society hinder any one from fighting out the battle of life on his or her own behalf to the best of one's ability, especially if they so hinder one to the advantage of another, the field of effort for intelligent and fruitful reform is at once marked out; but, if examination should reveal no such operation of laws and institutions, then the inequality of achievements is no indication of any social disease, but the contrary.

The indication of social health or disease is to be sought in quite another fact. The question whether the society is formed of only two classes, the rich and the poor, the strong and the weak, or whether all the intervening grades are represented in a sound and healthy proportion, is a question which has importance, because it furnishes indications of the state and prospects of the society. No society which consists of the two extreme classes only is in a sound and healthy condition.

If we regard the society of a new country, with little government regulation, free institutions, low taxes, and insignificant military duty, as furnishing us with the nearest example of a normal development of human society under civilization, then we must infer that such a society would not consist of two well-defined classes widely separated from each other, but that there would be no well-defined classes at all, although its members might, in their extremest range, be far apart in wealth, education, talent, and virtue. Such a society might, as it grew older, and its population became more dense, develop, under high competition, great extremes of economic power and social condition, but there is no reason to suppose that the whole middle range would not be filled up by the great mass of the population.

I have now cleared the ground for the proposition which it is my special purpose, in this paper, to offer:

It is the tendency of all social burdens to crush out the middle class, and to force the society into an organization of only two classes, one at each social extreme.

It is in the nature of the case impracticable to adjust social burdens proportionately to the power of individuals to support them. If this could be done, it is possible that the burdens might become great, even excessive, without producing the effect which I have stated. Since, however, it is impossible to so adjust them, and they must be laid on "equally" with reference to the unit of service, and not with reference to some unit of capacity to endure them, it follows that the effect must be as stated. So soon as the burden becomes so great that it surpasses the power of some part of the society, a division takes place between those who can and those who can not endure it. At first, those who are close to this line, but just above it, are not far removed from those who are close to it, but just below it; but, as time goes on, and the pressure continues to operate, they are constantly separated from each other by a wider and wider interval.

Let us look at some of the historical facts which show us this law.

If we take the early Roman history as Mommsen relates it to us, we observe the constant recurrence of the difficulty which arose from the tendency of the society toward two extreme classes. It was plainly the pressure of military duty and taxes which was constantly developing two classes, debtors and creditors. The demands of the state fell upon different men in very different severity according to circumstances.* One found himself just so well established that he could endure without being crushed. Another found that the time demanded, or the wound received, or the loss sustained by an inroad, or by being on an unsuccessful expedition, threw him back so that he fell in debt. The former, securing a foothold and gaining a little, bought a slave and established himself with a greater margin of security. Slavery, of course, mightily helped on the tendency. Twenty years later the second man was the bankrupt debtor and bondman of the first.

All insecurity of property has the same effect, above all, however, when the insecurity is produced by abuse of state power. In the later history of Rome, the Roman power, having conquered the world and dragged thousands born elsewhere into Italy as slaves, set to work to plunder its conquest. The booty taken by emperors, proconsuls, and freedmen favorites, and by the sovereign city, was shared, through the largesses, with the proletariat of the city. The largesses and slavery worked together to divide the Romans into two classes. The plunder of the provinces intensified the wealth of the wealthy. The largesses pauperized and proletarianized the populace of the great city.† They drew away citizens from the country, and from honest industry, to swell the mob of the city. If a band of robbers should split into patricians and plebeians and divide the plunder unequally, it is plain that, as time went on, they must separate into two great factions, one immensely rich, the other miserably poor.‡ As for the victims, although at first the severity and security of Roman law and order were not too dear even at the price which they cost; nevertheless, the inevitable effect of robbery came out at last, and the whole Roman world was impoverished.# Those only could get or retain wealth among the provincials who could gain favor with, or get on the side of, the rulers. No satisfactory exposition of the political economy of the Roman commonwealth has yet been written. The effect of the Roman system on population, on the development of capital in the provinces, on the arts and sciences, on the distribution of the precious metals, on city population at Rome and Constantinople, on the development of talent and genius, offers lessons of profound importance, touching in many points on questions which now occupy us. The Roman Empire was a gigantic experiment in the way of a state which

* As to the heavy burdens of Roman citizenship, see Merivale, viii, 284.

† See Mommsen, book iii, chapters xi, xii; book v, chapter xi; Pöhlmann, "Die Uebervölkerung der antiken Gross-Städte," Leipsic, 1884.

‡ See especially Friedlaender, "Sittengeschichte," i, 22: "In the enjoyment of the extravagant abundance of advantages, excitements, and spectacles, which the metropolis offered, the highest and lowest classes were best off. The great majority of the free male inhabitants were fed partly or entirely at public expense. The great found there an opportunity and means for a royal existence as nowhere else on earth. The middle classes were most exposed to the disadvantages of life at Rome."

See Merivale, viii, 351; Gibbon, chapter xxxvi, at the end.

took from some to give to others. "At the beginning of the third century already the signs of a fatal loss of vitality manifested themselves with frightful distinctness, and spread with such rapidity that no sagacious observer could deceive himself any longer as to the beginning dissolution of the gigantic body." *

All violence has the same effect. In the fifth and sixth centuries of our era, the general disorder and violence which prevailed gradually brought about a division of society on a line which, of course, wavered for a long time. A man who was strong enough in his circumstances to just maintain himself in such times became a lord. Another, who could not maintain himself, sought safety by becoming the lord's man. As time went on, every retainer whom the former obtained made him seem a better man to be selected as lord; and, as time went on, any man who was weak but independent found his position more and more untenable.†

Taine's history of the revolution shows distinctly that the middle class were the great sufferers by the revolution. Attention has always been arrested by the nobles who were robbed and guillotined. When, however, we get closer to the life of the period, we see that, taking France over for the years of the revolutionary disorder, the victims were those who had anything, from a peasant or a small tradesman up to the well-to-do citizen.‡ The rich bought their way through, and the nobles were replaced by a new gang of social parasites enriched by plunder and extortion. These last come nearer than any others whom history presents to the type of what the "committee" in a socialistic state may be expected to be. #

All almsgiving has the same effect, especially if it is forced by state authority. The Christian Church of the fourth and fifth centuries, by its indiscriminate almsgiving on a large scale, helped on the degeneration of the Roman state.‖ A poor law is only another case. The poor-rates, as they become heavier, at last drive into the workhouses the poorest of those who have hitherto maintained independence and paid poor-rates. With this new burden the chance of the next section upward to maintain themselves is imperiled, and so on indefinitely.

All taxation has the same effect. It presses hardest on those who, under the conditions of their position in life and the demands which are made upon them, are trying to save capital and improve their circumstances. The heavier it becomes, the faster it crushes out this

* Friedlaender, i, preface. While reading the proof of this article, I have read Professor Boccardo's "Manuale di Storia del Comercio, delle Industrie e dell' Economia Politica" (Torino-Napoli, 1886), in which, pp. 74, 75, he expresses the same view as is above given more nearly than I have ever seen it elsewhere.

† See Gibbon, chapter xxxviii; Duruy, "Histoire du Moyen Age," 233, 234; Hallam's "Middle Ages," chapter i, part ii; Seebohm, "The English Village Community," chapter viii.

‡ See vol. iii, book iv, chapter i. # See vol. iii, book iii, chapter iii. ‖ Pöhlmann, 62.

class of persons—that is, all the great middle class—and the greater the barrier it sets up against any efforts of persons of that class to begin accumulation. If the taxes have for their object to take from some and give to others, as is the case with all protective taxes, we have only a more intense and obvious action in the same direction, and one whose effects must be far greater and sooner realized. The effect of protective taxes in this country to drive out the small men, and to throw special lines of industry into the hands of a few large capitalists, has been noted often. It is only a case of the law which I am defining.

My generalization might even be made broader. It is the tendency of all the hardships of life to destroy the middle class. Capital, as it grows larger, takes on new increments with greater and greater ease. It acquires a kind of momentum. The rich man, therefore, can endure the shocks of material calamity and misfortune with less distress the richer he is. A bad season may throw a small farmer into debt from which he can never recover. It may not do more to a large farmer than lessen one year's income. A few years of hard times may drive into bankruptcy a great number of men of small capital, while a man of large capital may tide over the distress and put himself in a position to make great gains when prosperity comes again.

The hardships and calamities which are strictly social are such as come from disorder, violence, insecurity, covetousness, envy, etc. The state has for its function to repress all these. It appears from what I have said that it is hard to maintain a middle class on a high stage of civilization. If the state does not do its work properly, such classes, representing the wide distribution of comfort and well-being, will die out. If the state itself gives license to robbery and spoliation, or enforces almsgiving, it is working to destroy the whole middle class, and to divide society into two great classes, the rich who are growing richer, not by industry, but by spoliation, and the poor who are growing poorer, not by industrial weakness, but by oppression.

Now, a state which is in any degree socialistic is in that degree on the line of policy whose disastrous effects have here been described. The state, it can not too often be repeated, has nothing, and can give nothing, which it does not take from somebody. Its victims must be those who have earned and saved, and they must be the broad, strong middle classes, from whom alone any important contributions can be drawn. They must be impoverished. Its pets, whoever they may be, must be pauperized and proletarianized. Its agents alone—that is, those who, in the name of the state, perform the operation of taking from some to give to others—can become rich, and if ever such a state should be organized, they may realize wealth beyond the dreams of a proconsul.

To people untrained in the study of social forces it may appear the most obvious thing in the world that, if we should confiscate the property of those who have more than a determined amount, and divide the proceeds among those who have less than a certain amount, we should strengthen the middle class, and do away with the two extremes. The effect would be exactly the opposite. We should diminish the middle classes and strengthen the extremes. The more we helped at the bottom, the more we should have to help, not only on account of the increase of the population and the influx of eager members of "the house of want," but also on account of the demoralization of the lowest sections of the middle class who were excluded. The more we confiscated at the top, the more craft and fraud would be brought into play to escape confiscation, and the wider must be the scope of taxation over the upper middle classes to obtain the necessary means.

The modern middle class has been developed with, and in, an industrial civilization. In turn they have taken control of this civilization and developed social and civil institutions to accord with it. The organization which they have made is now called, in the cant of a certain school, "capitalism" and a "capitalistic system." It is the first organization of human society that ever has existed based on rights. By virtue of its own institutions, it now puts itself on trial, and stands open to revision and correction whenever, on sober and rational grounds, revision can be shown to be necessary to guarantee the rights of any one. It is the first organization of human society that has ever tolerated dissent or criticism of itself. Nobles and peasants have never made anything but Poland or Russia. The proletariat has never made anything but revolution. The socialistic state holds out no promise that it will ever tolerate dissent. It will never consider the question of reform. It stands already on the same footing as all the old states. It knows that it is right, and *all* right. Of course, therefore, there is no place in it for reform. With extreme reconstructions of society, however, it may not be worth while to trouble ourselves. What we need to perceive is, that all socialistic measures, whatever their degree, have the same tendency and effect. It is they which may be always described as tending to make the rich richer and the poor poorer, and to extinguish the intervening classes.

MISGOVERNMENT OF GREAT CITIES.

By FRANK P. CRANDON.

GREAT cities are essential to the development of any important or influential national life. They gather into themselves the resources of the nation, and so organize its stores of wealth, its enterprise, and the results of its genius and culture, as to render each efficient in promoting the common good. They are the centers of power. Without the facilities which through them are afforded for commerce and manufactures, without their aggregations of capital, their business systems and institutions, and their fostering care of art, science, and literature, it would seem impossible that there could be any civilization or progress.

These great municipalities are the exponents of the national advancement in material wealth, in commercial importance and influence, and in all forms of intellectual and moral culture. In times past they have been the agencies through which civil and intellectual freedom have been conserved, even if they may not be credited with having been the nursery in which liberty was cradled. They constitute the medium through which we must study many of the most important and interesting phases of history, and are the sources of all the greatest enterprises of the world.

So thoroughly do cities become representative of national life and characteristics, that it is frequently said that London is England, Rome is Italy, and Paris is France. In a less comprehensive but nevertheless very important sense it might properly be said that New York represents America, Boston stands for New England, and Chicago for the great West. A thorough acquaintance with either of these great cities is equivalent to knowing well the people by whom they are surrounded.

Notwithstanding their important relation to all that is significant or influential in national life and history, it is nevertheless true that there has never been developed anything, which even by courtesy, could be called a science of municipal government. Indeed, it is only within these latest years that the fact that there could be such a science has even been suggested. But the pressure has been constantly growing more and more imperious. Monstrosities which are the legitimate fruit of the hap-hazard system, or rather lack of system, which characterizes the government of many cities, evils of administration and burdens of taxation that had become almost unendurable; the astounding frauds which have been brought to light within the last few years in New York and Philadelphia, and the usurpation of power by demagogues through the aid of the most degraded elements of society, have at last forced an inquiry as to what form of municipal government will most efficiently correct present abuses and reduce to the minimum the opportunities for harm to the body politic.

Men begin to ask whether the municipal authority may not be so organized and administered that it shall promote and protect the interests of both the corporation and the individual; whether the evils to which I have alluded, and others equally apparent and subversive of the ends of good government, are inherent in our municipal system or only incident thereto. And some effort has been made to ascertain the principles which underlie a legitimate municipal authority and the most efficient means of making the application of those principles practical.

Not a very great deal has been accomplished by this study. The problem is complicated and many-sided. Its solution depends on careful and extended observation, and on the concurrent action of wise, patient, self-sacrificing, and public-spirited citizens. In this study the conclusions of purely theoretical political economists, and of those men whose thought and experience have been limited to special aspects of the subject, are alike unsafe and misleading: the first, because political communities never afford the proper conditions for the application of abstract principles; and the second, because the entire machinery of government is so interdependent and complicated that successful modifications of any special department imply corresponding changes in all the associated agencies. But whatever difficulties may embarrass the subject, we have good cause for congratulation in the fact that the problem is being studied, and not altogether studied in vain.

The evils growing out of the misgovernment of cities may be grouped in two general divisions: First, those which are the legitimate fruit of systems which are in themselves vicious, and which can only be corrected by a radical change in the governmental machinery; and, second, those which result from the abuse and corrupt use of agencies which in themselves are proper and beneficent, but which, in the hands of designing men, come to be efficient aids of fraud and the most obnoxious forms of wrong-doing. This class of evils can only be corrected by devising some means which shall keep the government in the control of its best citizens. Can this be done, and, if yes, then how?

Let us first note some of the difficulties of the problem, and then ascertain, so far as we may be able, what are the possibilities and methods of its solution.

As a primary proposition it may be stated that the lack of a general and comprehensive act of incorporation has been the cause of endless embarrassment and difficulty in the management of city affairs. In many States the method of municipal incorporation has been by the granting of special charters. These charters possess no uniformity as to the powers conferred, but in each case represent such powers as the persons asking for them deemed it desirable to have, or such as the Legislature could be induced to confer.

Frequently it has happened that neither the incorporators who were seeking charters, nor the legislators who granted them, were persons who had had such experience in municipal affairs as to guarantee that the corporations which were to be created would be possessed of needful powers and restrained by proper limitations. Ordinarily, almost as a matter of course, there would be found but little difficulty in starting off the new municipality, for its most obvious needs would have been recognized and provided for, but as little or no thought had been taken as to the future demands which would be made upon it, and no adequate provision had been made for the needs of a largely increased constituency, it would by-and-by be demonstrated that the powers and privileges which were amply sufficient for the small constituency were too limited when the growth of the city demanded increased facilities and improvements.

An attempt would then be made to meet these demands, not by abrogating the original act of incorporation and substituting for it such a system as should be comprehensive and sufficiently elastic to respond to all legitimate demands that should be made on the governing power, but by amendments and additions, and the substitution of boards of commissions, until the whole system became inextricably involved. As a result we find in many municipalities separate boards of control for the government of the fire and police departments, election boards, school boards, boards of health, boards of visitors, and so on, until the multiplication of authorities has subdivided responsibility into homœopathic quantities. The tendency is also to apply the homœopathic treatment, and, on the theory of *similia similibus curantur*, to meet the constantly increasing difficulties by the creation of more of these boards and commissions.

We have in this country had an extensive and disastrous experience in this constant effort to meet the increasing demands of local government by supplemental legislation, but so far as I can ascertain we have not yet even approximated the achievements of our English cousins in this patchwork style of city government.

The English municipal reform bill was passed in 1834. Since then there have been passed seventy additional acts, all of which are in force, and which are applicable to all boroughs. These are supplemented by nineteen further acts, which, to a greater or less extent, effect these municipal organizations.

In addition to these acts I find it stated in a number of the "Contemporary Review" that there was, at least until recently, comprised within the limits of one poor-law union, two municipal boroughs with town councils, eleven local board districts, three boards of guardians, twenty-four bodies of overseers, five burial boards, two school boards, and one highway board—in all forty-eight local authorities, each acting independently and having jurisdiction in the same territory; a condition of things that would seem in contrast to render Babel a veritable haven of rest.

Our own experiments with this system of government by local boards and special commissions, whether these independent bodies have been created to meet some pressing need for which the organic act of incorporation did not make provision, or whether organized in the hope of rescuing a part of the municipal machinery from the control of the Tweeds and McManes and their disciples and imitators have been alike disastrous: the first, because the *imperium in imperio* is necessarily self destructive; and the second, because the vultures which prey upon the body politic will as certainly find the means to control these special organizations as they have hitherto found the means of dominating other governmental machinery, will man them with their own agents, and thus make them the subservient tools of a criminal regency.

Chicago struggled along under burdens of this sort for a good many years, but at last in sheer desperation it surrendered its original charter, together with all the ornaments with which subsequent legislation had decorated it, and organized under the general incorporation law of Illinois. So far as it has been tested, this law seems to have been wisely and intelligently framed, and, while it is adapted to the wants of small constituencies, it is sufficiently elastic to meet the demands of large cities. It at least possesses the important feature of making a single body responsible for the municipal government, and the executive becomes personally and directly responsible for the direction and administration of municipal affairs. Under it Chicago has thus far by no means attained to an ideal city government. Indeed, the events of the last year would indicate that it had but illustrated how thoroughly a good agent may become prostituted to evil purposes. Nevertheless, the imperfections of our municipal government (and their name is legion) exist in spite of the character of its organic system, rather than in consequence of it.

It is an important matter to definitely locate responsibility. When the responsibility can be subdivided among several independent bodies, or is shared by the chiefs of various departments, it rests with no special weight upon any individual. But when it can be located, when the people can come to the derelict councilman, or to the chief executive, and say, "Thou art the man," good men will always be more careful, and even bad men will become circumspect.

This principle is constantly attracting more and more attention. Boston has recently made some radical changes in her municipal system, which, while they do not go so far in the direction of localizing responsibility in the person of the chief executive as is now true of the city governments of New York and Brooklyn, still largely increase the power of the mayor, and make him to a greater extent than ever before responsible for the conduct of municipal affairs.

There can be but very little doubt that this will be found to be a change in the right direction, and all students of municipal reform will be interested to note whether, after testing this principle, the Boston constituency will not be inclined to give it even a more emphatic application.

But no system, however good in itself, is self-executing. It is not enough that the government shall be founded on right principles. Its administration must also be in the hands of trained and true men. This is a matter almost lost sight of in municipal affairs. Men are selected for city officers for almost every conceivable reason than that which should outweigh every other consideration, namely, their ability to discharge the duties thus devolved upon them. They are selected because they are Republicans or Democrats or Mugwumps. Perhaps they are politicians, and must be paid for services rendered. It may be that they have influential friends who desire to provide for them in the public service, or for some equally insufficient reason they are placed in charge of interests for the care of which they are utterly incompetent.

A private enterprise conducted on this plan would soon come to a most disastrous result, and every intelligent man would declare that such a result was deserved and inevitable. But seldom is this rule applied in passing judgment on public affairs. There seems to be a kind of undefined belief that public interests can be cared for by almost any persons, or that they can for the most part care for themselves, or that they are in some inscrutable way under the care of that Providence which is said to protect the lives and persons of idiots and inebriates. When the plundering of the public revenue is discovered, when the ballot-boxes are stuffed or stolen, and when by official incompetency or rascality the public safety or the public health is jeopardized, men shake their heads ominously, give a passing moment to reflections on the depraved state of municipal affairs, indulge in a few evil predictions, and pass on to their banks, their factories, or their merchandise, leaving these affairs to drift on to a destruction concerning which the only question is as to whether the *dénoûment* is more or less remote. Then, when the disaster or evil is upon them, and the effort to provide a remedy can no longer be postponed, relief is sought from some additional legislation or to some new device of administration, rather than by a resort to the simple and common-sense plan of putting municipal affairs in the hands of skilled and honest administrators. As to the methods of securing such officers, I shall have something to say farther on. In the administrations of city governments we find misgovernment manifesting itself in so many forms that it would be impracticable to make note of all its phases. Nor would such an effort prove interesting, even if perhaps it might be instructive.

To those pronounced and flagrant forms of misgovernment which arrest the attention of even the casual observer, I shall not at this time allude, except as I may suggest some method of correction. It will be well, however, to refer to some less obtrusive instances which may not always be suggested to us in our examinations. And first, let us note the liability to mistake in connection with our public charities. The sentiment which pervades every rank and condition of society, demanding that relief be given to the suffering and that the wants of the needy be supplied, is creditable to humanity. It has, too, most abundant opportunities for exercise. No proposition has been more fully confirmed by the experience of mankind than that "the poor ye have always with you." In many of our municipalities the charge for poor-relief is one of the heaviest items of expense. How to render this assistance so as to secure the greatest good, and to do the least harm to those who are aided, is a question very difficult of solution. Public institutions, such as almshouses, hospitals, and infirmaries of various kinds, must of necessity be provided. In no other form can we meet the demands which we have neither the right nor the disposition to ignore. These benevolences, however, are not always managed in the interests of either the inmates or of the municipality. Officers are appointed and dismissed according to their subserviency to the appointing power. Employés who are not utterly incompetent to discharge the duties devolving upon their positions, and others who are not expected to perform any duties, are carried on the pay-roll, and the semi-seclusion and retirement which seems to invest such institutions, to a certain extent protects the details of their operations from public scrutiny. Complaints seldom receive attention, or are regarded as the querulous vagaries of an impaired intellect, and it is only in some of those spasmodic convulsions which occasionally rock to the very center some city government that we obtain an inside view of these affairs. At such times the public sensibility is apt to be shocked at the revelations which are brought to light, and the people wonder that evils of such magnitude could have existed undiscovered in their very midst.

There is another form of public charity which in the West we call "outside relief"—i. e., temporary aid in necessitous cases, which in the aggregate constitutes a very large expense, and the effect of which is not easily ascertained. Charitable aid in substantially this form seems to be a necessity in every community. Just how far it ought to be a gratuity is a matter deserving careful consideration. I am quite sure that this form of poor-relief is frequently so administered as to encourage pauperism. It creates a class of dependents who become imbued with the idea that such support is an inalienable right; all stimulus to industry and thrift is lost, and "pauperism becomes a profession."

I have a friend who, at a time when there was great want and suffering among the poor of Chicago, established a free Kindergarten where, during the day, little children could be left by their mothers, who thus had freedom for any employment which they could secure. This was continued until a change in business affairs seemed to obviate any further necessity for such a charity. The school was then closed, and its patrons became indignant. There seemed to be no gratitude for favors received, but rather a sense of personal wrong in the withdrawal of what had come to be looked upon as a permanent arrangement for their benefit. The effect of this charity was in the direction I have indicated. It begat a spirit of dependence on the part of its beneficiaries, and relaxed their sense of obligation to provide for their own necessities. I believe it to be a typical illustration.

It is a difficult thing to bestow a charity in such a way as not to do harm to the beneficiary. In so far as it is practicable, there ought to be some kind of *quid pro quo;* aid granted should take the form of payment for some kind of service rendered, even if the service be of no value to the donor.

The city of Providence is moving in this direction. No donations are made to transient mendicants. Vagrants, tramps, and beggars are taken in charge by the police. Food and temporary lodging are provided by the city. A certain amount of labor is demanded of each able-bodied recipient of relief in payment of his entertainment, and the result is that that city is shunned by the professional pauper as if it were a pest-house.

Illustrative of another manner in which charities become perverted from their originally beneficent purpose, I would refer briefly to a report as to the London guilds, made by the City Companies Commission, published not long since in the "Pall Mall Gazette." These guilds or societies were originally benefit societies or charitable associations, and were under the care and protection of the city. In process of time they become the trustees of various bequests made for securing an annual income to some charitable institution or purpose. The guilds were simply trustees of this property, never its owners. As years passed by, the operation of natural causes enormously increased the value of the properties under their care, so that they are now estimated to be worth from $75,000,000 to $100,000,000, and the annual profits about $4,000,000. But the guilds as trustees only pay over to the charity funds the income on the original value of the bequests. As, for instance, where the rental of a certain realty was at the time the bequest was taken in charge by the guild $100, it is now $10,000; the guild, however, pays over to the charity the $100 and pockets the $9,900. Not a member of these guilds is entitled to a penny of this money; yet, by a system of "payment of privileges," which is a polite way of saying "the purchase of a right to steal," these guilds, besides spending hundreds of thousands of dollars of these trust-funds in banquetings and entertaining their friends in a sumptuous manner, pocket annually a handsome income for themselves.

The members of the guilds are, by virtue of said membership, invested with the municipal franchise, and are permitted to vote either in person or by proxy, and thus are admitted to the very select number who control the affairs of this immense metropolis. Mr. Gladstone not long ago characterized these guilds as associations for the cultivation of gastronomy, which occasionally gave a five-pound note to charity.

In a number of instances like provision was made for the support of churches and schools in particular localities. The changes caused by the demands of trade long ago deprived both churches and schools of their constituency. But the farce of maintaining religious worship in one place and a form of instruction in the other is maintained in order that the incomes appropriated to their support may not be sacrificed. The clergyman lives ten, fifteen, or twenty miles distant. He has no parish, and in some instances no congregation, but he comes to the church and goes through a form of religious service once or twice on Sunday. In one instance it was discovered that one man constituted the entire audience, and that he was paid a certain sum each week for playing congregation while the clergyman conducted the service!

In the city of London there are several parishes whose limits do not extend beyond the walls of the church-building—but which are in receipt of very generous incomes. In an article on the Bank of England, by Henry May, in the "Fortnightly Review," we are told that "this edifice" (the Bank) "was greatly enlarged between the years 1770 and 1786, and was completed pretty much as it now stands in 1786; an act having been procured in 1780 to enable the directors to buy the adjoining church, land, and parsonage—in fact, the whole parish of Christopher Le Stock—to the rector of which non-existent parish the bank pays four hundred pounds sterling per year to this day."

I am not aware of anything in America which parallels this condition of affairs. Our country is not as yet old enough for this; our conservatism is not of the right type, nor our veneration for such a class of "vested rights" sufficiently pronounced to afford favorable conditions for the existence of such abuses. I do not think it probable that they could maintain an assured footing among us. But we may be well warned against a system which tends in this direction, which is in itself vicious, and which must ultimately involve us in greater embarrassments.

The efficiency and success of a municipal government depend in a great measure upon its police establishment. The protection of life and property, the security of peace and good order, the suppression of crime and the arrest of criminals, are the special care of this department. Failure in these particulars is a fatal defect. Success in this branch of the government would palliate and atone for many shortcomings elsewhere. So far as I am able to learn, our American cities have no well-organized and well-sustained police force. Almost everywhere the police organization is used as a partisan political machine. If we recall the events of the past eighteen months, the statement will be confirmed, and we will find that the Republicans of Cincinnati and the Democrats of Chicago seem to vie with each other for an unenviable supremacy in this direction, and that each seems likely enough in its turn to surpass the other. The difficulty is fundamental, and relates to the theory of organization. Appointments to the police force, and promotions in the service, are made at the dictation of professional politicians, and as a reward for partisan services. A failure to perform these services is equivalent to an application for discharge. Efficiency in the line of duty will not atone for a lack of zeal in elections, and skill in detecting crime is of less moment or value than skill in managing primaries or conventions. Thus, the *morale* of the force is constantly being depreciated. It is impossible to appeal to its professional pride, its enthusiasm, or its professional *esprit de corps.* And the members of the organization, instead of constituting a dignified and respectable department of the municipal government, degenerate into time-serving placemen.

As a matter of experience, we have learned to expect, at the end of a newspaper paragraph announcing the perpetration of a crime, the assurance that no arrests have been made; and the comparative immunity of the criminal classes among us is a continual disgrace to our civilization.

The police system of some European cities is far more efficient than anything of the same sort in this country. Especially is this true of Paris. It may be objected that in the latter city the system is too efficient, and partakes *too largely* of a method of espionage and surveillance. I think that this objection would be valid. The Parisian police force would not be, and ought not to be, tolerated in any American city; but the reasons for this apply to some of the inquisitorial and detective purposes for which the force is used, and do not apply to the plan on which it is organized.

I would make the police service a profession in the same sense that the army is now a profession. Let its rank and file be composed of enlisted men who would be subject to discipline and dishonorable dismission for proper cause, in accordance with appropriate regulations adopted for the government of the force, but who could not be otherwise discharged. Let the officers be gentlemen trained to their profession, men holding a commission as honorable and desirable as that held by a military officer and subject to similar conditions. Let promotions be made for faithful and efficient service, and in recognition of exceptional ability.

Let the service be organized on the theory that it is a worthy profession for men of high character and ability. Let it be lifted out of the domain of politics and take its proper position as a department of the city government—a department which can in no way be affected by the mutations which attend the annual elections—and we would have as a result a police force which, either as to its *personnel* or the character of the work which it would perform, would be unexcelled.

The best method of raising the revenue necessary for carrying on the municipal government is an intricate problem, and one which, at one time or another, has received a great deal of attention. The systems in operation in different localities are widely different, and the proper discussion of any of them would not be practicable at this time.

There are, however, two features of this subject which I am not willing to pass in silence:

1. As to that class of *quasi* public corporations, such as street and elevated railways, ferries, gas companies, and the like, which derive all their privileges from the municipal government and are subject to its control. From modest beginnings these organizations frequently grow to vast proportions, and their plant and franchise become a most valuable property.

When first introduced the popular demand for this class of improvements ordinarily enables these companies to secure specially favorable terms from the municipality. As time passes they become thoroughly established and wealthy, even if they do not become arrogant and defiant. Their contributions to the revenues of the city, however, continue to be based on the favorable conditions under which they were first brought into existence, and in no sense amount to a fair return for the privileges and immunities granted to them. In all such cases the city might be protected by reserving to itself a fair proportion of the receipts of these companies, which should be in lieu of all other forms of taxation.

Under such an arrangement the tax on the corporations would be determined by their own prosperity, being light when their earnings were small, and larger with their increased ability to pay, and the city would receive a just return for the benefits it conferred.

2. I would call attention to the exemption of certain property from the payment of its share of the public burdens. I refer to the elaborate and costly church edifices which are so prominent a feature of every large city. Though I do not believe that the position is logically sound, nevertheless it is in accordance with the traditions of this people, and in harmony with the principles on which our State and national governments are founded, that buildings used for public worship should be exempted from taxation, and to this practice, as applied to modest structures of reasonable value, I do not offer any opposition. But it seems to me to be clear that the magnificent structures which abound in all our large cities can not claim a place in this category.

It is scarcely a proper use of language to denominate them houses of *public* worship. Though they are nominally open to the public, still their appointments, their furnishings, the style of their services, their practically reserved seats, the restrictions as to the time of admission of any except pew-holders, and the accommodations provided for the public, all warrant the statement that they are really the private religious club-houses of wealthy parishioners, whose right to erect and maintain and enjoy them is unquestionable, but whose right to do all this at the public expense is by no means so apparent.

These institutions share in all the benefits of the city government, are guarded by its police, are protected by its fire department, are approached by streets lighted, cleaned, and paved at its expense, and, in the event of their unlawful destruction, the municipality would be liable to respond in damages for their full value—all this for the accommodation of a small fraction of the people. It seems to me that the value of these structures, at least so much of it as exceeds a certain reasonable limit, should be taxable. No principle is more firmly imbedded in our political system than that the support of religious worship and institutions shall be entirely voluntary. The exemption of this class of property from taxation violates the principle, in that it is a forced contribution on the entire community to the extent of the exemption ; and it is the less defensible, in that the exemption is in favor of that portion of the community that could with the least difficulty meet its obligations.

If the matter were presented in the form of a proposition for a direct tax for the maintenance of the churches, it could not find support in any quarter. No community in our land would consent that either the State or the municipality should levy any direct tax to be appropriated for the support of religious services or institutions. Why it is the less objectionable, because it takes the form of special exemption from a common liability, I am utterly unable to understand.

Another instance of the abuse of municipal authority (and the last to which I shall refer at this time) may be found in the legislation affecting railway corporations. The constantly increasing volume of railway traffic demands almost daily increasing facilities for its accommodation. New railways are constantly seeking entrance into or a right of way through all our large cities. The granting of new franchises as well as the regulation of the train-service on all lines ; the protection of those streets which are either crossed or traversed by railway-tracks; the construction of viaducts and bridges, are matters in which the municipality and the railway corporations are mutually interested, and which ought all to be considered and decided simply in accordance with their relation to the public interests. As a matter of fact, the public interests have very little to do with such decisions. The railway companies have learned that any legislation which they may want, however necessary and proper it may be, and however much it may promote the general welfare, must be well paid for ; that any privileges, however legitimate, which affect either their own interests or the interests of their patrons, can only be had by the payment of a price to the city government.

Within a few years a certain railway corporation applied for a right of way into Chicago, on a route by which a great deal of the most valuable property of the city was seriously damaged. At first no one seemed to think that the project could be *bona fide.* When it became apparent that the corporation was in earnest, it was still felt that it would be utterly impracticable for the company to secure from the City Council such an ordinance as would enable it to carry out its plans. But the matter was in the hands of able attorneys and shrewd business managers. Step by step it progressed, and finally became a consummated fact. It was freely charged and is universally believed that the ordinance cost the railway company half a million dollars! So far as I can learn, the charge has never been denied.

Within the last few months another railway project was inaugurated. Application was made to the Chicago City Council in its behalf for an ordinance granting the right of way into the city, and for the right to lay its tracks in certain streets. The application was powerfully supported by one of the great railway organizations of the West, and was as vigorously opposed by a rival company of equal wealth and influence. As the contest proceeded it attracted very general attention and interest. In the discussions had in reference to the matter it came to be openly asserted, both in private conversation and in the public press, that those members of the Council who favored the proposed ordinance were in the pay of one corporation, while those who opposed it were classed as the paid agents of the rival company!

In the discussions to which the matter gave rise, the idea that any member of the Council advocated or opposed the ordinance on its merits did not seem to present itself to any one. I do not mean to affirm that the facts were in harmony with this theory. Indeed, it is very certain that the City Council of Chicago is in part composed of gentlemen of the highest integrity and character. But I noticed these expressed opinions as indicating the standard of public sentiment. People have become so accustomed to venality on the part of municipal legislators, that the first impulse is to interpret their official actions as the *quid pro quo* of money considerations, and experience proves that as a rule the theory is correct.

In support of my conclusions let me quote a single paragraph from a pamphlet entitled "Problems of Municipal Government for Chicago," by Hon. D. L. Shorey, who has for many years been a member of the City Council of that city, and who deservedly ranks among Chicago's best and ablest citizens. He says: "There is a wide-spread impression that a majority of the Council is venal. Assuming that this is true, it certainly shows a very bad state of affairs, and that there is imperative need for reform in that body. The evil is even more dangerous than is generally supposed. The disease really exists elsewhere, and is only manifested in the Council. There is an outside purchaser for every venal vote. In this case the purchaser is the more dangerous man of the two. He is probably an officer in some moneyed corporation; is sometimes a member of some fashionable church, stands high in financial and social circles, and is an influential factor in controlling public opinion. On the other hand, the Council is largely composed of young and untried men of moderate social distinctions. Such men have neither the social nor intellectual fiber to resist a moneyed temptation, and it is no marvel if three out of four of them are not able to resist such temptation."

Mr. Shorey here admits judgment by confession, and his opportunities for knowing whereof he affirms are especially favorable. Without waiting to determine whether, as Mr. Shorey says, the man who makes merchandise of a public trust is less culpable than the other man who purchases what the trustee offers for sale, we will at least agree that we have fallen upon evil times, if the public interests are to be subordinated to the office-holder's cupidity.

It is not strange if private corporations, finding that they can only obtain legitimate privileges and authority by the payment of a certain largess or bounty, attempt to secure, perhaps, by the payment of an additional fee, perquisites and privileges which a proper regard for the public interests would deny them.

The magnitude of this danger can not be exaggerated. Private rights and interests are jeopardized, and, if maintained at all, are only so maintained at the price of an expensive litigation, which is a substantial denial of justice. Competition is prevented or crushed out by the potent agency of gold, and the public, bound hand and foot by its own trusted agents, is surrendered to the greed and avarice of private corporations.

The practice of purchasing municipal legislation is not peculiar to American cities. Thomas Hare, in "Macmillan's Magazine," says, as to London: "The ascertained cost of legislation, to the companies who are forced to seek it, is enormous. Railway bills have cost from £650 to £1,000 per mile. Power to make twenty-nine miles of railroad cost the Hereford Company £250,000, equal to $1,250,000; and, before a spade was put in the ground, the Great Northern Railway had paid £420,000, or $2,100,000, in parliamentary costs!"

Is it not reasonable to expect that companies paying such enormous charges will attempt to obtain privileges and concessions somewhat commensurate with the outlay involved; and that they will endeavor to recoup from the public the money which they have paid in securing their charter privileges?

No opposition will be offered to this proposition:

"It should be practicable for any corporation to obtain a legitimate and proper franchise without the payment of fees for legislative favors. It ought always to be understood that illegitimate privileges or concessions prejudicial to the interests of the community could not be obtained at any price."

The recent developments in the matter of the Broadway Surface Railroad disclose a condition of affairs not only disgraceful to the venal participants in the infamy, but perilous to the community. It does not seem too much to demand that the municipal government be placed on a basis which will protect the public against such a prostitution of municipal powers.

The security of the public in all these cases is in the *personnel* of the city government. If it is practicable to put into that government men of character and integrity, and only such men, the problem is solved. If this be not practicable, it would seem as if the only alternative is to go on from bad to worse, until the whole municipal system breaks down under the weight of evils which are inseparably connected with its present organic form, and makes way for some new system of governmental control.

And this brings us to the consideration of the ways and means of correcting and preventing the evils which have been referred to, as well as the long, long list of other evils which from time to time force themselves upon the attention of the public.

[*To be continued.*]

A SCIENTIFIC MISSION TO CAMBODIA.

By M. MAUREL.

THE countries now known as Cochin-China, Annam, Cambodia, Laos, and Siam, and probably the whole Indo-Chinese Peninsula, were occupied primitively by a dark-colored race, remnants of which are still to be found in the mountains, on whom their conquerors, all having the same feeling toward them, have imposed names which in their several languages mean savages. At a period in the past which probably answered to the beginning of the Christian era, two conquering peoples took possession of the richer parts of the country and drove these tribes back into the mountains. They established the kingdom of Thiampa in the south, and that of Cambodia in the central region. Cambodia, now small in extent and weak, was formerly a powerful empire, and held under its allegiance, either directly or as tributary states, more than half of the Indo-Chinese Peninsula. Its splendor is attested by its numerous monuments of grand dimensions and beautiful architecture. Yet this Khmer people, which has left such admirable traces of its power and civilization, is an enigma to the world. We know very little of its origin, and hardly more of the period of its power. Its history, as we have it, prevents various phases of struggle and alliance with its neighbors, China, Siam, Thiampa, and Tonquin. It is supposed to have attained its highest state of splendor in the arts in the eleventh century. At the beginning of the eighteenth century it divided Thiampa with Annam and Tonquin. From that time on it suffered a succession of losses of territory till, in 1863, Norodom, its king, placed it under the protectorate of France.

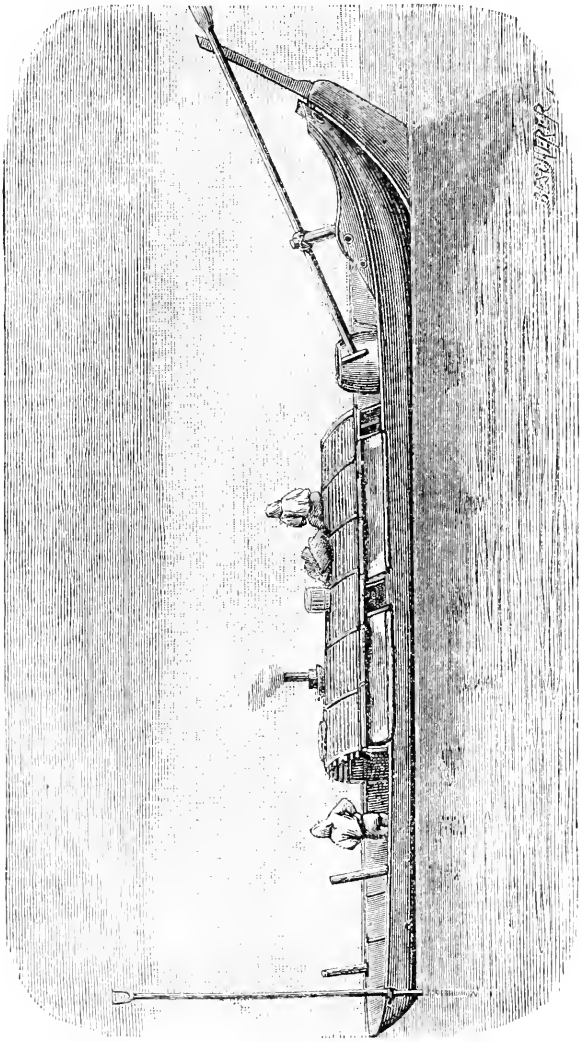
Cambodia is situated between 10° 30′ and 14° north latitude and 100° 30′ and 104° 30′ east longitude, and has an area of about 100,000 square kilometres, and a population of 1,200,000 souls, of whom 700,000 are Khmers. It is traversed by the great river Me-Kong, which rises on the eastern skirts of the Thibetan table-land, crosses

Yunnan and Laos in a narrow valley, and, entering Cambodia, pours its waters over it for about four months of every year. In the heart of this country the river is divided into three arms, two of which continue their course as the front and the back river, while the third turns back toward the Toulé-Sap lake. This arm presents the phenomenon, which is believed to be unique, of flowing during part of the year in one direction, and the rest of the time in another. When the snows melt, it is swelled to above the level of the lake, and turns its flood into it, and away from the sea. The lake thus serves as a waste-weir and regulator, and is capable of holding in reserve some thirty-five milliards of cubic metres of water. But this is not enough, and in some seasons the water, overflowing the banks of the river and its affluents, covers at least a third of the country and transforms it into a sea navigable for boats having a very respectable draught of water. This periodical inundation has impressed the manners and customs of the Cambodians with a peculiar stamp. The lake itself forms a prominent feature in the life of the people. It is about seventeen miles wide and ninety miles long, and furnishes in its fisheries one of the most reliable sources of the country's wealth.

The character of the Cambodian house is largely determined by the phenomenon of the inundation. It is built on piles, often, on one side at least, some twenty or twenty-five feet above the ground. The piles on one side stand in the river, and the door is on the other side. All that the proprietor asks is that the floor shall be a few inches above the water in time of freshet. He might put it on the level ground near the stream, but he prefers to have it overhang, in part at least, and slope. The floor is reached by ladders, which are drawn up in the evening—the surest mode of closing the house in a country where there are no locks.

Under the floor the pirogue is moored on one side, while the poultry, dogs, and pigs live on the other side. The pigs have hollow backs and their bellies drag on the ground, but their owner does not disdain to share his abode with them. I have seen the Cambodian and his pig lying side by side at noonday, enjoying their *siesta*. Places are also found under the house for the wagons, plows, and fishing-tackle. The floor is usually a wicker-work of woven bamboo laths, which bend and creak at every step, and which we, with our shoes and heavy walk, find it hard to get over. But the Cambodian walks light-footed and carefully, much as we try to do when we go on tip-toe, but, not being troubled by shoes, with vastly better success. Bending his legs a little and leaning forward, with his arms brought up toward his chest, he puts his foot delicately on two or three of the slats at a time, and walks noiselessly on, while we would always feel as if we were going to break through. These open floors are easily cleaned with a dash of water which runs off, no one cares where. In case the inundation should threaten to rise above them, the owner can make another floor higher up, with some bamboo sticks and a few hours of time.

The house is only one story high. The framing of the roof except for the larger pieces, which are of timber, is made with bamboos of sizes graduated to correspond with the weight they are intended to support. It is covered with a shingling of palm-leaves, or with wisps



Cambodian Pirogue.

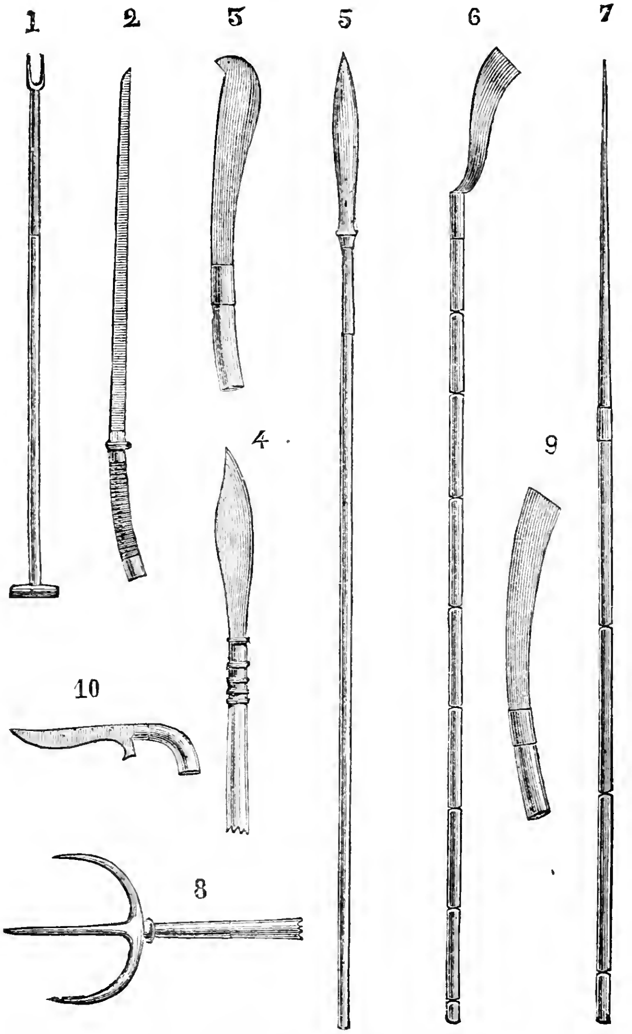
of straw, after the fashion of a European thatch. The outside walls and the partitions are often made in the same way. Inside, the house is divided into three or more apartments. The first, the vestibule, usually open in front, is reached by the ladder. Next to it is the principal room, serving for *salon*, dining-room, and bedroom, and from this doors open into the private family rooms or apartments of the women and children, to which Europeans are not admitted, and native visitors but rarely. Two small rooms are also occasionally built by the sides of the vestibule for the young men. The girls, whatever their age, always live with their mother. The whole structure is some thirty-five or forty feet square. Besides his dwelling-house the Cambodian builds a taller house, also on piles and having no entrance except by a small window, which he is particular to make tight against the rain ; and this is the granary for his rice.

This description answers for the more common houses of the country—for those which are occupied by people in moderate circumstances. There are also other kinds of houses. The poor sometimes have to be contented with a low hut covering only a few square yards. The wealthy citizen may use timbers and planks instead of bamboo, but even the highest functionaries do not possess jointed planks. Luxury demands fine wood, but it is not carefully worked ; and in the houses of the ministers of state one can walk on planks two or three inches thick, showing very evident gaps, and not even nailed to the joists on which they rest.

These primitive huts are far removed from the ideas we have of Oriental luxury, and still further from those which we might conceive from the ruins that exist in the country. At present Cambodian construction does not go beyond wood. Only the pagodas are of stone, and there is nothing in any of those which are standing to remind us of the splendors of the past.

There is one town, the city of Compong-Chnang, of variable population, which may rise to five thousand during the fishing season, that is built entirely on floating rafts. The people carefully follow the movements of the water, drawing their houses toward the land when it rises, and pushing them out into the stream when it falls, but always so that they shall be close to the shore without getting aground. Nothing can be more picturesque than the appearance of this town at evening when lighted by Chinese lanterns. The houses are separate from one another, and never but one story high ; and the streets are regularly laid out.

The Cambodian's furniture is of the most primitive character. A table, a few stools, some earthen or copper spit-boxes, a few jars, and a bedstead made of boards, compose the useful part, while the ornamental is furnished by the arms and musical instruments hung on the walls, and mats laid upon the ground. When we go into these large rooms, we find them so scantily furnished, in comparison with our overloaded apartments, that we can hardly realize that they are occupied. But, then, what use has the Cambodian for bureaus, chairs, and tables? He has no wardrobe but his sampots, and he sits and eats on the ground. Our furniture would be a superfluity to him. What luxury he indulges in is in the line of wives, slaves, pirogues, and elephants. The table is made of wood, the stools are of bamboo, and the jars are of copper, or cocoanut, or calabash. The inventive spirit of the people has been particularly exercised on the bed. While he is satisfied with a few rough-dressed planks for a bedstead, the Cambodian has received from his fathers and still displays great skill in



CAMBODIAN ARMS. 1, hand-spear; 2, sword; 3, 4, 5, 6, 9, white arms of different forms; 7, javelin; 8, trident; 10, poignard.

making his mat and his mattress. The mat is an ordinary mat with tightly twisted tufts of cotton on the under side. The art of making these tufts is a special one, peculiar to the Khmer people. The mat is a valuable article in a country where journeys are often taken, for it furnishes a sufficient bed, and is easily packed with the baggage. The necessity of making frequent removals has also inspired the Cambodian mattress. The mat is not thick, and furnishes a comfortable relief ; but the Cambodian sybarites have sought for something better, and found it. They have invented a mattress as soft as our own and much more convenient for journeys ; it can be folded up into so compact a space as to take up very little room, and it is made in such a way that, however thick it may be, it can always be done up so exactly that every part shall be sure to fit into the smallest possible space. These luxurious bed-clothes are, of course, only found among the better-off Cambodians. The poorer ones have to content themselves with a common mat, or a board, or the ground itself.

KING OF CAMBODIA.

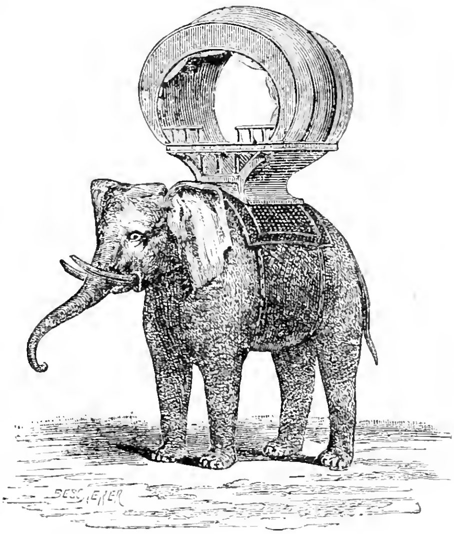
The spittoon is in universal use. It varies in size and material, but not in shape. It is swelled out at the base, narrowly contracted above, and flares out into a funnel at the top—the whole giving it a shape well adapted to its use. The Cambodian is a constant betel-chewer ; he has to be spitting all the time, and is under the necessity of having a dish always at hand to receive the blood-red saliva that escapes from his lips. The poor use an earthen spittoon. The rich man uses porcelain, and King Norodom has a spittoon of massive gold, carved and dressed with great taste.

The housekeeping leaves much to be desired. One of the prominent characteristics of the people is to build and not keep up. This applies to their monuments, their houses, their boats, and their objects of art. But they do some cleaning, and use in it brooms made of the median nerves of palm-leaves and of cocoanut-fibers. They do very little in the evening. Their labors are performed during the day, which in that latitude is of nearly even length the year round. But if a man wishes to light his house or travel by night, he can use various torches, the most common of which is made of dried palm-leaves, tied together and steeped in resin. They are good enough to go around by, and are identical with the torches used by the natives of the Malabar coast. When they want a more steady light in the house they make little candles by dipping a cotton wick in melted wax and working it in the hand. This is really an article of luxury and is usually employed only before the altars in ancestral worship.

The Cambodian lives on rice and fish, and drinks water. Every other article of food or drink is to him only an accessory. Cambodian rice is one of the poorest kinds, being small and generally mixed with hard grains. It is thrashed out roughly, and is decorticated only as it is used. Fish is eaten fresh or salted, and, as the fishing-season is constant, there is always plenty of it, with a considerable surplus for exportation. The "extras" are chickens, eggs, pork, vegetables, and fruits, the chief of which is the banana. Tea is rarely taken at meals, but is served during the day, and offered to visitors. But little use is made of fermented liquors, and drunkenness is very rare. The liquor met most frequently is an alcohol of rice perfumed with essence of roses, which is known as *chum-chum*.

Their cookery is so strongly spiced that it is repulsive to Europeans. The Cambodian addresses himself by turns to pepper, ginger, mace, and various spices; but it costs the foreigner a long exercise to endure them. These, however, are condiments to which we are accustomed, and the only difference between our habits and theirs is in the quantity. But it is a different affair when we come to a product which the Cambodian likes well enough to set everywhere—the *nuoc-man*, or oil of fermented fish. The Annamites use this, too, but they refine it. The Cambodian prefers for his sauce to have it of the most pronounced flavor, without its having undergone any filtration or other process to attenuate its taste or odor. Offensive as it is at the first interview, I have known Europeans to learn to like it and to eat it with relish.

Instead of fireplace and chimney, the Cambodians use ingeniously constructed portable furnaces of terra-cotta. I find in this another illustration of the fact I have already referred to, that the inundation, by compelling the Cambodian to be a water-man for a part of the year, has given a special direction to his industry, the characteristic feature of which is the invention of portable utensils equally adapted to service on land and on his narrow pirogue, and also occupying but little space. The furnace of Campong-Chnang is in the shape of a calabash, divided by a horizontal plane into two parts. The smaller end, provided with three legs, is the kettle; and the other end holds the coal, wood, and ashes. With this apparatus the native can do his cooking anywhere, on the ground or on the lightest boat, without danger of fire. Nothing could be better for its purpose. The people also have a taller kind of furnace, but it is less convenient and more fragile, and is not in general use. The vessels for cooking have nearly always the same shape, and differ only in size. Vessels of the same kind are also used for pitchers, and when designed for this purpose are furnished with a withe, which, after being wrapped around the narrow part several times, is formed into a handle. They are used in pairs, and carried by means of a bar over the shoulders. The meals are eaten sitting on the ground. Tables are used only to put things on temporarily. The countrymen have two meals—the first at ten o'clock in the morning and the other at five o'clock in the afternoon. In the towns they sometimes have three—the first at nine o'clock, the second at one, and the last at six o'clock in the evening. The one-o'clock meal is light, and consists chiefly of a pottage of rice. The others are more substantial, and include, besides rice, which takes the place of bread, fresh fish in the morning and salt fish in the evening; and when they have chicken and meat, it is at these meals. At meal-time the members of the family collect around a mat which is set in a particular part of the house, the usual place for that house, but different in different houses. They sit on the ground, with their legs thrown over to one side. Some of them, perhaps, will squat, in what is an habitual position of resting with this people. The wife in a poor family, or a slave in wealthier ones, then brings in a dish furnished with bowls containing the meats, one of which is given to each *commensal.* In the event of a more elaborate repast, where a variety is provided, the different dishes are brought on in succession. But this is rare; for the Cambodian, like the people of warm climates generally, is extremely sober, and it is not without considerable astonish-



CAMBODIAN ELEPHANT AND TENT.

ment that he sees us swallow, at a single meal, a quantity that would suffice him for two or three days. The whole dish is screened with a hood of straw, covered with cloth, which protects the meats against dust and keeps them warm. The head of the house removes the cover, and they all fall to with a will. When several dishes are provided, they all take a little of each at once, and it is only a little, so that the plate is often passed back. For service, the Cambodian employs his fingers, not even having the Chinese chopsticks, and using a little bowl, or a Chinese spoon, only to take up the sauce. The repast is usually eaten in silence, and occupies but a few minutes. When it is over, the servant brings a towel and the family wipe their hands; then they rise and go to the water-jar to wash their hands and drink a cup of water. The Cambodian never drinks while he is eating. Such is the meal of ordinary well-off people, as simple as possible, and free from all parade of dishes—no linen, no covers, no knives, no glasses; hardly a cup for each person, and only a family drinking-cup at the water-jar after the meal. Such simplicity should seem to exclude all idea of luxury; but it exists. It is shown in the enrichment of the few dishes that are used. The plates of the poor man are plain; those of the rich are decorated; and they may be of earthenware, of porcelain, of copper, plain or chased, of silver or gold.

Cambodians

Tea is reserved for refreshment between meals, and to be offered in compliment to visitors. Whoever goes into a Cambodian's house is offered tea, and it is a sign of esteem and friendship to take it. A refusal would be misconstrued.

The costume of the Cambodians is peculiar to them. The *sampot* is their only native garment, for all others that they may wear may be regarded as Siamese or Annamite importations. The manner of wearing it is distinctive to the Khmer race, for the other people of the country wear it differently. The sampot is a strip of cloth about a yard wide by three yards long, generally woven whole, and after patterns that have come down from remote antiquity. With the common people it is cotton, with well-to-do people it is silk, while the rich sometimes have it trimmed with silver or gold. It is put on by wrapping around the loins and bringing the ends forward; then, taking it by its upper edge, at about half a yard from the body, the two handfuls of cloth are twisted round each other, and it is tied with the same kind of a knot as the Chinese and Annamites use to fasten their trousers, while the parts of the ends beyond the knot hang down in front; then they are twisted up, passed between the legs, carried back and fastened behind to the strip over the loins. The legs are thus enveloped in a kind of wide breeches. This constitutes the whole of the Cambodian's country costume. He is otherwise barefooted, bareheaded, and barebacked. Richer men, however, wear under the sampot short drawers of light, white goods; and townspeople wear over it a belt with a metallic plate, which they have adopted from the Siamese. Another imported garment is the Siamese paletot, a coat fitting the shape, opening and buttoning in front, and coming down to the hips. The sleeves are straight and of the full length of the arms. The nobles and mandarins have very recently adopted the European short-coat; and the dandies have borrowed a scarf which properly belongs to the women. They usually wear it tied around the waist, while a few throw it over the upper part of the body; but this is a violation of the rites, and those who commit it are cautious enough to let their scarf drop when they see any high functionary of their race coming. The hair is worn short behind and three or four inches long in front. It is parted in the middle or at one side, and set off with a flower behind the ears. Women also wear the sampot arranged in the same fashion as that of the men, but without the drawers, and of a different color from the masculine garment, it being the woman's peculiar privilege to wear green and rose color. Their scarf is usually of silk, and of some striking color, different from that of the sampot, and is gracefully thrown over the body so as not so much to hide the breasts as to give them support; and the Cambodian woman is not at all concerned if her breasts are fully exposed. Some women wear a kind of robe or chemise with tight sleeves extending over the sampot to just above the knees. They wear their hair short; and this, with the likeness of their dress to that of the men, and the men's smooth faces, makes it a matter of no little tact to tell a man from a woman.

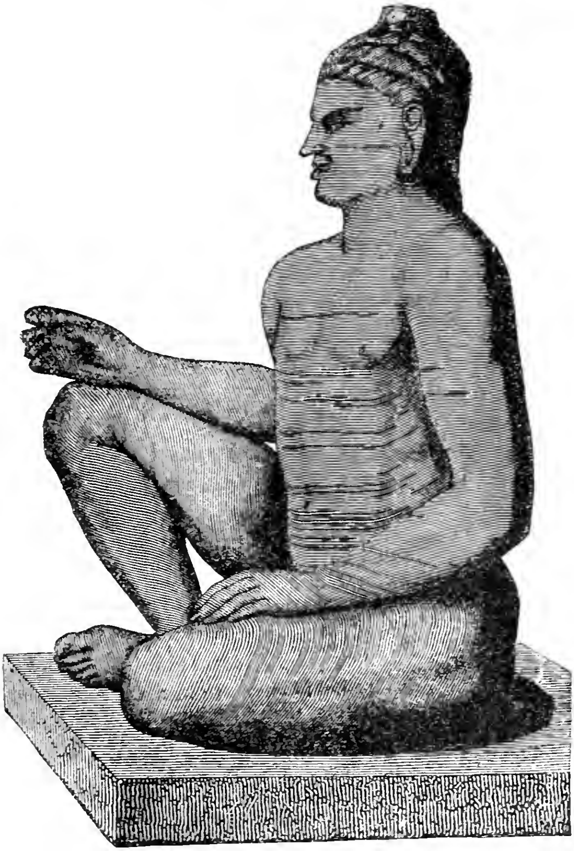
Children of both sexes go nearly naked till they are about seven years old. Their hair is the object of one of the most cherished customs of the Khmer people. At two years of age it is cut off, all except a tuft on the top of the head, which is left to flow, or is tied up or fastened with a pin till the youth reaches the age of puberty. It is then cut off with a solemn ceremony, marked by rites which have come down from antiquity, to witness which all of the family and the *bonzes* are invited. In the royal family the occasion is honored by grand festivals, in which all the people participate.

The Cambodian is an indefatigable walker, a good horseman, and a boatman of rare skill. His favorite sports are boat-races, tennis, and shuttle-cock, to the last of which adults devote themselves with great zest. The shuttle-cock, which is thrown by the toe, often passes from one pair to another fifteen or twenty times without touching the ground. These games of skill are, however, second in favor to the games of chance, of which *bacoing* and the game of the twenty-six

STIENG SAVAGE, COCHIN-CHINA.

animals are the chief. The former game is common to all the extreme East, and even numbers many Europeans among its votaries. The game of animals is more peculiarly Cambodian. It is a lottery, in which the numbers are represented by animals; and these give it life and touch the fancy of the players in a thousand ways. Roulette-players are sometimes struck by a particular number, and put a great deal of trust in it. How much more should an animal enlist their confidence! Its appearance, its voice, the direction of its course, are precious signs to the Cambodian player; and as he is, moreover, superstitious and frequently idle, it is easy to see how prominent a place these fascinating diversions occupy in his mind.

Like all people who have struggled for existence through centuries, the Cambodians rigorously preserve their usages. It appears that as the power of a nation declines, and its means of defending itself against foreigners become less effective, the people feel the need of establishing a rallying-point for their nationality, and find it in their institutions; and these they learn to cherish all the more as a memorial of the time of their national glory. Numerous old customs are preserved in this way in Cambodia. Perhaps the most interesting of them are those which relate to betrothals and marriage. Betrothals sometimes



STATUE OF THE LEPROUS KING, FOUNDER OF ANGKOR WAT.

take place at a very early age; but in case the parents have not entered into any engagement, and the young man has made his own choice, he addresses a woman whose business it is to attend to such matters, and employs her to sound the heart of his chosen girl and the disposition of her family. If his overtures are accepted, he visits the house of the young woman, making his salutations at the foot of the stairs and at the top, and explains the object of his visit to her parents.

They receive him, and generally accept him as a betrothed suitor. when he takes up his abode in the house and becomes a kind of domestic, almost a slave, to the family, assisting them in all their labors. In this way they have an opportunity of judging what he is good for. The length of this time of trial is controlled by the degree of hesitation manifested by the young woman; but the waiting has its compensations. She makes it her business to prepare the quids of betel and the cigarettes for her swain. This done, she puts them in a convenient place where he will find them, or she may venture to offer them to him herself. The residence under a common roof is accompanied by corresponding privileges. If the authorized relations are passed, and children are born, they are regarded by the law as legitimate. Betrothed are protected by the same legal sanctions as married women, and the groom has the same right over her as he would have over a wife. The difference between betrothal and marriage is that betrothal is more easily withdrawn from. If the rupture comes from the groom, he has only to go away; if from the young woman, her parents must pay him an indemnity proportional to the services which he has given during his residence in the house.

To admire the arts of Cambodia we must go back into its past. We can gain some conception of what they were by looking at those immense monuments that confound our Western pride by their dimensions, the beauty of their proportions, and the finish of their details. Angkor Wat, although deserted by the crowds that once gave it life, plundered by the vandalism of conquerors, and disintegrated by time, still bears comparison with the finest of our monuments. The religious sentiment has never conceived anything more elevated or grander. We are forced to believe that when architecture had reached such a height, the other arts must follow it if only at a distance. The two thousand square yards of bas-reliefs which decorate the halls of the pagoda of Angkor, and the hundreds of statues it contains, testify for sculpture. The condition of music and poetry is attested by the airs and songs which we still hear—the same that resounded under the ceilings of the holy places centuries ago. There is no room to doubt that luxury and the arts once flourished in the Khmer country.—*Translated for the Popular Science Monthly from the Revue Scientifique.*

THE WHITE-FOOTED MOUSE.

By CHARLES C. ABBOTT, M. D.

OFTEN, as early in autumn as the first of October, the abandoned nests of cat-birds and cardinal grosbeaks, and to some extent those of the brown and song thrushes, will be found very frequently to be tenanted by those beautiful little mammals, the white-footed mice (*Hesperomys leucopus*).

While the fact of such situations being chosen by these mice, for their winter quarters, has been long known, I am not aware that observation has been carried beyond this point; and I recently endeavored to determine, first, to what extent these old birds' nests are remodeled; and again, whether or not some of them may not be constructed *de novo*, the builders using the abandoned home of a bird for the exterior of the new structure, and removing it, bit by bit, from its original site.

In the months of October and November of the past year (1885) I examined a series of forty-two nests, all of which were above the ground, and occupied by mice. All were strikingly different from any nest of a bird, such as is found in so exposed a position; none being open above, nor having the materials for linings such as our thrushes and larger finches are accustomed to use.

Of the series thirty-one were placed in dense tangles of *Smilax rotundifolia*, or green-brier. None were near the upper or outer edges of the thicket, but usually about one third the distance from its uppermost surface, and midway from side to side: for instance, if the growth was ten feet high and six or eight in width, the home of the mouse would be at an elevation of between six and seven feet; and it had therefore a protecting growth of thorny smilax of three to four feet in extent above it, and nearly the same upon each side.

This was a very uniform feature of the series examined, and, if the mice merely occupy old nests of birds, indicates a uniformity in the matter of their locating by the birds, of which I was not aware, and which I am inclined to doubt.

Again, the smilax was so very dense or closely intertwined, in the majority of instances, that it was clearly impossible for a bird as large as a robin or grosbeak to have penetrated it with that celerity of movement necessary to escape the impetuous charge of a hawk. It is, I think, far more probable that the continuous growth of the green-brier, after the birds abandoned the nest, made it in many cases inaccessible.

During my almost daily visits to these bush-retreats of the white-footed mice, I determined one fact about the density of these growths of smilax, as late as October: that the small hawks, and even smaller shrike, found sparrows and mice quite out of reach when they took refuge therein. In one case, a sharp-shinned hawk, a little more rash than usual, struck at a snow-bird, as the latter dived into some opening in the briers, and, instead of capturing it, the hawk was himself hopelessly entangled.

Four of the forty-two nests occupied by the mice were placed in clusters of blackberry-canes, a growth which proved to be by no means easy to penetrate, but probably would offer no serious obstacle to a determined foe, but certainly could not have been suddenly assaulted—a condition which rendered the occupants comparatively safe.

The remaining seven nests were in a mixed tangle of Virginia creeper and grape-vine. These seven nests were all at a greater elevation than any I found in smilax or other thorn-bearing growths; one nest being thirteen feet from the ground.

These bush-retreats of the mice were all distinctly globular, or globoid, with the entrance usually near the rim of the original structure, and looking downward. These original structures were not merely covered at the top, but distinctly arched over; and the exterior often had a "pulled-to-pieces" appearance that suggested a chance accumulation of twigs and dead leaves, rather than designed.

A careful examination convinced me that twenty-nine were nests of cat-birds, cardinal-grosbeaks, or song-thrushes, and two were nests of the robin; all of which had been built by these birds in May or June of the same year—five or six months previously. The nests of the robin are apparently less popular, on account of the partial or complete mud-lining.

In this series of twenty-nine nests I determined that the foundations and lower portion of the sides, for about one half their extent, were unaltered to any significant extent; and many appeared as if a smaller bird's nest had been bodily removed, inverted, and so used as a roof to the lower structure. Whether the rougher exterior, to which I have alluded, was due to exposure since early summer, to unskillful work on the part of the mice, or a design of these mammals to render the nests less conspicuous, could, of course, not be determined.

Eight of the series were to me quite unlike birds' nests in their construction. The interlacing of the twigs was not like the ordinary work of birds; and the internal capacity of each one of this series was much smaller than that of an ordinary cat-bird's nest; while the exterior measurements were the same or nearly so—thus showing great difference in the thickness of the walls of the structure.

Three of these eight nests I picked to pieces, and the lining proved to be a mass of downy feathers—how they got them is a mystery—and an abundance of the "silk" of the milkweed; this being a material not used by any of the birds I have named, and indeed not ready for use until after bird-nesting is over.

Still, I am not yet prepared to make an *ex-cathedra* statement that these mice do build bird-nest-like structures in smilax and other dense growths, without having at least the base of a bird's nest as a starting-point; yet, why they should not, does not readily appear, when we remember that they build beautifully designed nests in hollow logs, tufts of grass, and under flat stones. Such nests are their ordinary summer homes.

It is certain that the materials for these summer nests, which, as a rule, are on or very near the ground, are often carried from quite distant points; so, why should they not carry them up a few feet into tangled growths, offering almost as sure a footing as the ground itself?

To recapitulate: judging from the number of nests examined—of course, another such series might give different results—the winter retreats or bush-nests of the white-footed mice are usually modified birds' nests; but in some cases the modification appears to be extended to practically a new construction.

Once within their nests, the white-footed mice are not readily disturbed during the day; and, unless the smilax or other growth is greatly agitated, they will not even take the trouble to look about them. By gently cutting my way toward the nest with a pair of shears, snipping here and there a branch or two, and drawing others gently aside, I have never failed to successfully surprise the timid occupants in their snug retreats. It is fairly safe, therefore, to conclude that I procured a pretty accurate knowledge of the number of occupants of each nest, the relative proportion of the one to the other sex, and of old and young. Thirty-six nests contained each a female mouse, and of these twenty-two were associated with young able to walk, while the others were burdened with the care of helpless offspring but a few days old. In not a single instance did I find a male mouse in these nests, while in the six other nests each was found to contain a single adult male mouse and no other occupant.

This unsocial condition of affairs seems to me the more strange, as in several nests placed upon the ground—many such nests are occupied the year round—both parents were found. They were not accompanied by any offspring, however; and it would seem as though a separation took place on the birth of a litter. Such facts tempt one to theorize, but I desist.

It was a pretty sight to see the mice when forced to quit their airy quarters in a thicket of smilax. Be the vine ever so slender, they took no uncertain steps, but tripped lightly down from point to point, and never arriving at a confusing corner. One female mouse turned just twenty times before she reached the ground. Once there, although she had proceeded very cautiously before, she suddenly disappeared. This, indeed, is always the case; but just where they go when they reach *terra firma* remains to be shown.

The prevalent impression is that every mouse has a subterranean retreat directly beneath the nest in the bushes, and passes from one to the other as fancy dictates. Their actions seem to bear out the truth of this, but I have never been able to discover such underground retreats in positions that conclusively showed they were frequently visited by the bush-dwelling mice above them. On the other hand, I have found the evicted mice to take shelter under dead leaves, pieces of bark, or limbs of trees. If disturbed from such lurking-places, they very seldom attempt to re-enter the elevated bush-nests, but scamper off over the weedy, leaf-strewed meadow.

Besides reconstructing nests of birds as dwellings for themselves, they convert others into magazines stored with carefully selected acorns, chinkapins, hazel-nuts, and corn; and so there really seems to be no necessity for bush-dwelling mice ever to return to the ground when once they have taken up their quarters in a smilax thicket—that is, return before the winter is over.

In this my experience is quite the opposite to that of others who have found underground retreats beneath the bush-nests, and have seen the mice, when forced to leave the latter, take refuge in them. It is possible, certainly, that these were burrows of the meadow-mouse (*Arvicola riparia*), and it would be hard to prove, in a meadow everywhere tunneled by mice and shrews, that the presence of burrowings, whether deep or shallow, beneath nests in bushes, was not merely a coincidence; and, again, I am quite sure the same tunnels are often used in common by widely different species of small mammals.

The stores of food for winter use are of much interest as connected with the subject of hibernation; but I can at present merely outline what I have seen, and what conclusions I have reached from such observations. It can be truthfully said that, while the white-footed mouse is not a hibernating animal, nevertheless it frequently hibernates. In other words, its prolonged sleeping, sometimes extending over several weeks, depends not upon the temperature, for I have seen them scampering over the snow when the mercury was nearly at zero, but upon their access to the food they have laid up for winter use. Cut this off and they will not starve, but pass into that curious torpid state which, with many mammals, continues for the entire season. I have experimented so frequently with them in regard to this, that I feel warranted in saying that one wonderful capability of the creature is, to be able to avoid starvation and its attendant horrors by *optional hibernation*.

Why, it will probably be asked, do so many of these mice quit their cozy quarters in or on the ground, and which have served them every purpose, and take all this trouble to build a new home in the bushes for the winter? It has been suggested that the nest was worn out, and better fitted for entomological research than for hesperomoid habitation. I had myself thought of this, but have never detected such abundant evidences of this disastrous condition as would warrant the removal; and certainly the fur of these creatures would carry, in all cases, a sufficient number of acari to bring about, in a brief space, a repetition of the plague.

The supposed excessive dampness during autumn and winter of many situations where the summer nests of the mice abound has also been urged as a probable reason for the marked exodus that, as we have seen, occurs on the approach of cooler and wetter weather; but the exposure to sudden summer showers would, in this respect, be more objectionable than the steadier rains and gradual melting of snow during winter; when, as a matter of fact, they are less apt to suffer from water encroaching upon their nests than at other times—the frozen condition of the rough surface tending to carry off the water and prevent its soaking into the ground. I have never found a nest that could not have been better guarded from the damps of winter than from those terrific cloud-bursts that recall the vivid description in Genesis of the Noachian deluge. During such rainfalls, for which the month of August is noted, very many white-footed mice are drowned.

From such scanty observations as I have been able to make, I am led to believe that the habit of such removals from the ground to the bushes has been brought about by the greater exposure to the attacks of enemies, when nesting upon the ground ; these enemies being weasels, minks, and crows.

The two mammals I have named are certainly more given to prowling about the haunts of the mice in winter than in summer ; and the crows, particularly when the ground is frozen, have often been seen tugging away at the unyielding stones or wood that sheltered such mice as had concluded that their present quarters were so favorably conditioned as to prove effectual against the assaults of whatever enemy might chance to come. The fact that the poor creatures sometimes suffered from an error of judgment led me to conclude that the representatives of the weasel family, that I have mentioned, and the omnivorous and omnipresent crow, are ever eager to capture white-footed mice whenever an opportunity occurs.

Probably years of further observation will prove necessary to clear up this important point of the cause that led to the habit of utilizing abandoned birds' nests ; but I have no doubt that the question of comparative safety of the two situations, the ground or a thicket of smilax, had much to do with it.

MANUAL INSTRUCTION.

By Sir JOHN LUBBOCK.

MR. MUNDELLA, in an interesting address which he delivered at the Polytechnic last year, took us Londoners somewhat severely to task because more is not done in the metropolis to provide for the intellectual wants of our people. Certainly I must admit, as a Londoner, that we are far from being as advanced as we could wish. I would, however, point out two reasons. In the first place, the areas of government in London are for many purposes too small. I have no desire to speak disrespectfully of vestries or vestrymen. But take the case of free libraries : London is reproached for having so few, but would Birmingham have had its magnificent library if it were governed by the vestries of the separate parishes? One reason which has defeated the efforts to establish free libraries in London has been that the parishioners have been told that, while the expense would fall on them, readers could come in from other parishes. A bill should be proposed next session to remedy this by amending the Free Libraries

Act in the metropolitan district by making the area that of the union instead of the parish. Again, why have we in our educational institutions so few members and students belonging to the great shopkeeping community? It is on account of the excessively long hours in London shops. This, again, is to a great extent owing to the difficulty in such immense communities of obtaining and securing common action. I hope that next session we may do something to mitigate this great evil. Free libraries and shorter hours in shops are two of the most pressing wants in London. Still, I can not help thinking that Mr. Mundella was rather too severe on us. Can any provincial city show a nobler work than that carried on by Mr. Quentin Hogg at the old Polytechnic Institution? The members and students now, I understand, number nearly ten thousand, and not only does Mr. Quentin Hogg devote an immense amount of time to the work, but the annual cost to him can not be much below £10,000 a year. If it had been in one of our provincial cities we should probably have heard more of it. Londoners are, perhaps, too modest. Our London School Board has done its work efficiently, and is generally blamed for spending too much rather than too little. Again, the stimulus which has been recently given to the cause of technical education in England has no doubt been very greatly due to the City and Guilds of London Technical Institute, so ably directed by Sir Philip Magnus. The Commissioners on Technical Instruction, in their interesting report on technical education, have given endless cases showing the great importance of technical instruction, and I can not help thinking that much more technical education might be introduced even into elementary schools. Something of the kind, indeed, is done in the case of girls by the instruction in needlework and cookery, which latter, I am happy to see, is showing satisfactory results. Why should not something of the same kind be done in the case of boys? There are some, indeed, who seem to think that our educational system is as good as possible, and that the only remaining points of importance are the number of schools and scholars, the questions of fees, the relation of voluntary and board schools, etc. "No doubt," says Mr. Symonds, in his "Sketches in Italy and Greece," "there are many who think that when we not only advocate education but discuss the best system, we are simply beating the air; that our population is as happy and cultivated as can be, and that no substantial advance is really possible. Mr. Galton, however, has expressed the opinion, and most of those who have written on the social condition of Athens seem to agree with him, that the population of Athens, taken as a whole, was as superior to us as we are to Australian savages."

That there is some truth in this probably no student of Greek history will deny. Why, then, should this be so? I can not but think that our system of education is partly responsible.

Technical teaching need not in any way interfere with instruction in other subjects. Though so much has been said about the importance of science and the value of technical instruction, or of hand-training, as I should prefer to call it, it is unfortunately true that in our system of education, from the highest school downward, both of them are sadly neglected, and the study of language reigns supreme.

This is no new complaint. Ascham, in "The Schoolmaster," long ago lamented it; and Milton, in his letter to Mr. Samuel Hartlib, complained "that our children are forced to stick unreasonably in these grammatick flats and shallows"; and observes that, "though a linguist should pride himself to have all the tongues Babel cleft the world into, yet, if he have not studied the solid things in them as well as the words and lexicons, he were nothing so much to be esteemed a learned man as any yeoman or tradesman competently wise in his mother dialect only"; and Locke said that "schools fit us for the university rather than for the world." Commission after commission, committee after committee, have reiterated the same complaint. How, then, do we stand now?

I see it, indeed, constantly stated that, even if the improvement is not so rapid as could be desired, still we are making considerable progress in this direction. But what are the facts? Are we really making progress?

On the contrary, the present rules made by the Education Department are crushing out elementary science. There are two heads elementary science may be taken under, which are known as "class subjects" or "specific subjects." Under the Code, there are four so-called class subjects, only two of which may be taken. One of them must be English, which I am afraid in a great many cases practically means grammar. Consequently, if either history or geography were selected for the second, elementary science must be omitted. It has been pointed out, over and over again, that the tendency must be to shut out elementary science, because the great bulk of the schools are sure to take history or geography. The last report shows how grievously this has proved to be the case. The President and Vice-President of the Council, in the report just issued, say that elementary science "does not appear to be taken advantage of to any great extent at present." This is a very mild way of putting it. Mr. Colt Williams says, more correctly, that "specific subjects are virtually dead." Mr. Balmer observes that "specific subjects have been knocked on the head." In fact, out of the four and a half million children in our schools, less than twenty-five thousand were examined last year in any branch of science as a specific subject. Take, for instance, the laws of health and animal physiology. Only fourteen thousand children were presented in this subject. Yet how important to our happiness and utility! Neither Mr. Bright nor Mr. Gladstone, I believe, ever learned any English grammar, and, as regards the latter, it has been recently stated, by one who knows him intimately, that the splendid health he enjoys is greatly due to his having early learned one simple physiological lesson.

Turning again to the class subjects, last year elementary science was only taken in forty-five schools out of twenty thousand. This, however, was not because it was unpopular, but simply on account of the rules laid down in the Code. According to Mr. Williams, grammar—which, under compulsion, was taken in over nineteen thousand schools—was not a popular subject, and, if only the Code permitted it, it would be dropped in half his schools. One of her Majesty's inspectors, in the last report, seemed to regard it as an advantage of grammar that "its processes require no instruments, no museums, no laboratories." This, on the contrary, is one of its drawbacks. It fails to bring the children into any contact with Nature. Indeed, Helmholtz is probably correct in his view, that the rules of grammar, followed, as they are, by long strings of exceptions, weaken the power of realizing natural laws. Again, it is surely undesirable to attach so much importance to the minutiæ of spelling. Dr. Gladstone has shown that the irregularities of English spelling cause, on an average, the loss of more than one thousand hours in the school-life of each child. "A thousand hours in the most precious seed-time of life of millions of children, spent in learning that *i* must follow *e* in conceive, and precede it in believe; that two *e*'s must, no one knew why, come together in proceed and exceed, and be separated in precede and accede; that uncle must be spelled with a *c*, but ankle with a *k*, and numberless other and equally profitless conventions! And this, while lessons in health and thrift, sewing and cooking, which should make the life of the poor tolerable, and elementary singing and drawing, which should make it pleasant and push out lower and degrading amusements, are, in many cases, almost vainly trying to obtain admission." At present, we really seem to follow the example of Democritus, who is said to have put out his eyes, in order that he might reason better. It was a truer instinct which identified the "seer" and the "prophet." It seems very undesirable that our rules should be so stringent as to lay down a "flattening-iron" over schools, but if the choice of subjects were dictated at all, why, of all subjects in the world, should grammar, with its dry and bewildering technicalities, be especially favored? I do not, however, wish to disparage grammar; all I desire is, that it should not block the way; that elementary science should have a fair chance. The three objections which are sometimes heard, especially at school-board elections, are over-pressure, over-expense, and over-education. That there is really no general over-pressure, Mr. Fitch and Mr. Sydney Buxton have satisfied most impartial judges. Still, the relief afforded by a change from literature to science, from books to nature, from taxes on memory to the stimulus of observation, is no doubt of the most grateful character.

Mr. Matthew Arnold, in his recent "Report on Certain Points connected with Elementary Education in Germany, Switzerland, and France," points out that in German elementary schools there is a "fuller programme" and a "higher state of instruction" than in ours. He takes Hamburg, as a good typical case, and he tells us that "the weekly number of hours for a Hamburg child, between the ages of ten and fourteen, is, as I have said, thirty-two; with us, under the Code, for a child of that age, it is twenty." And then, or I should rather say "but then," "the Hamburg children have, as the obligatory matters of their instruction, religion, German, English, history, geography, natural history, natural philosophy, arithmetic and algebra, geometry, writing, drawing, singing, and gymnastics, thirteen matters in all." In one of our schools under the Code, the obligatory subjects are "three—English, writing, and arithmetic. Of the optional matters, they generally take, in fact, four, singing and geography; . . . and as specific subjects, say, algebra and physiology, or French and physiology. This makes in all, for their school-week of twenty hours, seven matters of instruction." As a matter of fact, I have shown that comparatively few children are presented in any specific subject. But even if two are taken, this would only bring up the subjects to half those included in the ordinary German course. Mr. Arnold "often asked himself" why, with such long hours, and so many subjects, the children had "so little look of exhaustion or fatigue, and the answer I could not help making to myself was, that the cause lay in the children being taught less mechanically and more naturally than with us, and *being more interested*."

I feel sure there is a great deal in this; variety in mental food is as important as in bodily food, and our children are often tired simply because they are bored.

As to expense, it is really ignorance and not education which is expensive.

But then we hear a great deal about over-education. We need not fear over-education; but I do think we suffer much from misdirected education. Our schoolmasters too often seem to act as if all children were going to be schoolmasters themselves.

It is true that more attention is now given to drawing in some schools; and this is certainly a matter of very great importance, but some changes must be made in the Code before that development can be made which we should all wish to see. Manual work in boys' schools seems to be exactly parallel with, and in every way analogous to, that of needlework in girls' schools, and I am inclined to agree with Sir P. Magnus that the value of the one kind of teaching should be as fully recognized and assisted by the state as that of the other. Why could they not introduce carpentering or something of that sort, which would exercise the hands of the boys as well as their heads? I have myself tried an experiment in a small way in the matter of cobblery, and although the boys did not make such progress as to be able to make their own boots, they no doubt learned enough to be able to mend them.

The introduction of manual work into our schools is important, not merely from the advantage which would result to health not merely from the training of the hand as an instrument, but also from its effect on the mind itself.

I do not, indeed, suppose that, except in some special districts, we can introduce what is known as the "half-time" system, in the sense that the children will do ordinary work for wages, though Mr. Arnold tells us in his "Report on Certain Points connected with Elementary Education in Germany, Switzerland, and France," that in Prussia "the rural population greatly prefer the half-day school, as it is called, for all the children, because they have the elder children at their disposal for half the day."

I do not, I confess, see why a system so popular in Germany should be impossible in England; but what seems more immediately feasible is that our boys should be trained to use their hands as well as their heads. The absence of any such instruction is one of the great defects in our present system.

Such teaching need not in any way interfere with instruction in other subjects. Mr. Chadwick has given strong reasons for his opinion, "that the general result of the combined mental and bodily training on the half school-time principle is to give to two of such children the efficiency of the three on the long school-time principle for productive occupations."

Again, the Commissioners on Technical Instruction, speaking of schools in the Keighley district, say: "The most remarkable fact connected with these schools is the success of the half-timers. The Keighley district is essentially a factory district, there being a thousand factory half-timers attending the schools. Although these children receive less than fourteen hours of instruction per week, and are required to attend the factory for twenty-eight hours in addition, their percentage of passes at the examination is higher than the average of passes of children receiving double the amount of schooling throughout the country."

In our infant-schools we have generally object-lessons or some more or less imperfect substitutes of that kind for the very young children. But after this, with some rare exceptions, our teaching is all book-learning; the boy has no "hand-work" whatever. He sits some hours at a desk, his muscles have insufficient exercise, he loses the love and habit of work. Hence to some extent our school system really tends to unfit boys for the occupations of after-life, instead of training the hand and the eye to work together; far from invigorating the child in what M. Sluys well terms "le bain refraichissant du travail manuel," it tends to tear his associations from all industrial occupations, which, on the other hand, subsequently revenge themselves, when their turn comes, by finally distracting the man from all the associations and interests of school-life.

This principle of manual instruction has been elaborately worked out in Sweden, where it is known as the "Slöjd" system, by Mr. Abrahamson and Mr. Solomon, and has been already adopted in over six hundred schools. It has recently been the subject of a very interesting memoir by M. Sluys,* who was deputed by the Belgian Minister of Education to visit Mr. Abrahamson and report upon it. The importance of manual practice as an integral part of all education was long ago realized by the genius of Rousseau, and first worked out practically and as regards young children by Froebel. Basedon indeed, in 1774, introduced manual instruction as a counterpoise to mental work ; but Finland seems to be the country where the value of manual instruction as an integral part of education was first realized, when, thanks to the efforts of Uno Cygnæus, the Government enacted in 1866 that it should be an obligatory subject in all primary and normal schools. The system of Basedon appears to have been less successful than might have been expected, probably in great measure because the instruction was confided to artisans, whereas it seems to be of great importance not to separate the direction of the manual from that of the mental training.

There have been, indeed, two very different points of view from which manual instruction has been recommended. The first looks at the problem from a specially economical point of view. The school is arranged so as to elicit the special aptitudes of the pupils ; to prepare and develop the children as quickly and as completely as possible for some definite trade or handicraft, so as to, if possible, assure them, when leaving school, the material requisite of existence. In this way, it is maintained, that the wealth and comfort of the nation can be best promoted.

The second theory regards the manual instruction as a form of education ; the object is to give to the hand, not so much a special as a general aptitude, suitable to the varied circumstances of practical life, and calculated to develop a healthy love of labor, to exercise the faculties of attention, perception, and intuition. The one treats the school as subordinate to the workshop, the other takes the workshop and makes it a part of the school. The one seeks to make a workman, the other to train up a man. In short, the Swedish system is no preparation for a particular occupation, but is intended as a means of general development. The time devoted to manual instruction is there from four to six hours a week.

Of all handiworks, carpentering has been found most suitable. The work of the smith strengthens the arm, but it does not train the

* "L'Enseignement des Travaux Manuels dans les Écoles primaires de Garçons en Suède." Rapport présenté à M. Le Ministre de l'Institut Publique par M. A. Sluys, et conclusion de MM. A. Sluys et H. Vankalken. Bruxelles, 1884.

hand—tends rather, indeed, to make it too heavy. Moreover, the work is rather hard for children. In basket-work, the fingers alone are exercised ; few tools are required or mastered, the younger children can not finish off a basket, and it is an additional disadvantage that the work is done sitting. Bookbinding is too limited and too difficult ; moreover, it does not afford sufficient opportunities of progressive difficulty. Work with cardboard is in many respects very suitable, but it trains the fingers rather than the hand, and does not sufficiently develop the bodily vigor. On the whole, then, working in wood is recommended, and it is remarkable that it was long ago suggested by Rousseau :

> Tout bien considéré, le métier que j'aimerais le mieux qui fût du goût de mon élève est celui de menuisier. Il est propre, il est utile, il peut s'exercer dans la maison, il tient suffisamment le corps en haleine ; il exige dans l'ouvrier de l'adresse et de l'industrie et dans la forme des ouvrages que l'utilité détermine, l'élégance et le goût ne sont pas exclus.

Abrahamson has prepared a hundred models, which the children are successively taught to make, commencing with a very easy form, and passing on to others more and more difficult. The series begins with a simple wooden peg, and the series includes a paper-knife, spoon, shovel, axe-handle, flower-stand, mallet, boot-jack, a cubic décimètre, a mason's level, chair, butter-mold, and ends with a milk-pail.

When the model is finished it is inspected. If unsatisfactory, it is destroyed ; yet if it passes muster, the child is allowed to take it home. It is all his own work ; no one has helped. It is, indeed, found important that the children should make something which they can carry away, and much stress is laid on the condition that they should make it entirely themselves, from the beginning to the end. If one does one part, and one another, if one begins and another finishes it, neither practically takes much interest in it.

The objects made are all useful. At first, some were selected which were playthings, or merely ornamental, but the parents took little interest in articles of this character ; they were regarded as mere waste of time, and have gradually been discarded.

The different objects must be gradually more difficult. When the child is able to make any model satisfactorily, he passes on to the next. He must never be kept doing the same thing over and over again. Useless repetition is almost sure to disgust. The man has to do the same thing over and over again, but the child works to learn, not to live.

Lastly, I may mention that the objects selected are such as not to require any expensive outlay in the matter of tools.

The result, we are assured, gives much satisfaction to the parents, and great pleasure to the children.

A weak point in our present educational system is, that it does not awaken interest sufficiently to enable children generally to continue their education after leaving school. Yet, in addition to all other advantages, a wise education ought greatly to brighten life. Browning speaks of the wild joy of living; but that is not the sense in which life is ordinarily spoken of by the poets. They generally allude to it in a very different sense, as when Pope spoke of it as "life's poor play," observing in another passage—

> "These build as fast as knowledge can destroy,
> In folly's cup still laughs the bubble joy";

while Lytton said—

> "With each year's decay,
> Fades, year by year, the heart's young bloom away."

A well-known hymn lays it down as an incontrovertible proposition—

> "Brief life is here our portion,
> Brief sorrow, short-lived care."

But this is to a great extent our own fault. Too often we fritter away life, and La Bruyère truly observes that many men employ much of their time in making the rest miserable. Few of us feel this as we ought, some not at all. We see so clearly, feel so keenly, the misery and wretchedness around us that we fail to realize the blessings lavished upon us. Yet the path of life is paved with enjoyments. There is room for all at the great table of Nature. She provides without stint the main requisites of human happiness. To watch the corn grow, or the blossoms set; to draw hard breath over the plowshare; or to read, to think, to love, to hope, to pray—"these," said Ruskin, "were the things that made men happy."

Some years ago I paid a visit to the principal lake villages of Switzerland in company with a distinguished archæologist, M. Morlot. To my surprise I found that his whole income was one hundred pounds sterling a year, part of which, moreover, he spent in making a small museum. I asked him whether he contemplated accepting any post or office, but he said certainly not. He valued his leisure and opportunities as priceless possessions far more than silver or gold, and would not waste any of his time in making money. Just think of our advantage here in London! We have access to the whole literature of the world; we may see in our National Gallery the most beautiful productions of former generations, and in the Royal Academy and other galleries the works of the greatest living artists. Perhaps there is no one who has ever found time to see the British Museum thoroughly. Yet consider what it contains; or, rather, what does it not contain? The most gigantic of living and extinct animals, the marvelous monsters of geological ages, the most beautiful birds, and shells, and minerals, the most interesting antiquities, curious and fantastic specimens illustrating different races of men; exquisite gems, coins, glass, and china; the Elgin marbles, the remains of the mausoleum of the Temple of Diana of Ephesus ; ancient monuments of Egypt and Assyria ; the rude implements of our predecessors in England who were coeval with the hippopotamus and rhinoceros, the musk-ox, and the mammoth ; and the most beautiful specimens of Greek and Roman art. In London we may unavoidably suffer, but no one has any excuse for being dull. And yet some people *are* dull. They talk of a better world to come, while whatever dullness there may be here is all their own. Sir Arthur Helps has well said: "What ! dull, when you do not know what gives its loveliness of form to the lily, its depth of color to the violet, its fragrance to the rose ; when you do not know in what consists the venom of the adder, any more than you can imitate the glad movements of the dove ? What ! dull, when earth, air and water are all alike mysteries to you, and when as you stretch out your hand you do not touch anything the properties of which you have mastered ; while all the time Nature is inviting you to talk earnestly with her, to understand her, to subdue her, and to be blessed by her ! Go away, man ; learn something, do something, understand something, and let me hear no more of your dullness."

Not, of course, that happiness is the highest object of life, but if we endeavor to keep our bodies in health, our minds in use and in peace, and to promote the happiness of those around us, our own happiness will generally follow.—*Fortnightly Review.*

THE INTERMINGLING OF RACES.

By JOHN READE.

ABOUT a generation ago, before anthropology had been promoted to the rank of a distinct science, a good deal of noise was made by a school of writers who called themselves polygenists. By this school, which comprised a few men of recognized ability, it was rigidly maintained that no new race had been, or could be, formed by intercrossing. As the different human species had been created, so they had been found at the dawn of history, and so they would remain till the end of time. The theory of the polygenists, like a good many other subjects of controversy, was gravely affected by the revolution of which the publication of Darwin's great work marked the birth-time. Though it is still possible, even on the ground of development, that the main racial divisions of humanity may have come into being by separate evolutions, on portions of the earth's surface widely distant from each other, it is more in accordance with that doctrine to assume a slow and gradual differentiation from a single original type.

What that type may have been we have no means of ascertaining. Professor Grant Allen has, indeed, imagined "a tall and hairy creature, more or less erect but with a slouching gait, black-faced and whiskered, with prominent prognathous muzzle, and large, prominent canine teeth," whose "forehead was, no doubt, low and retreating, with bony bosses underlying shaggy eyebrows, which gave him a fierce expression, something like that of a gorilla"; and that such a creature existed in far-off prehistoric times Mr. Allen considers "an inevitable corollary from the general principles of evolution."* We may have some notion of what such a rough-cast of humanity would look like from the ideal representation of the Neanderthal man which forms the frontispiece to Mr. J. P. McLean's "Manual of the Antiquity of Man." But, whatever may have been the character of the early type, or however the subsequent divergence from it may have arisen, it is sufficiently established that, between the third and second millennium before the Christian era, the several races—black, brown, yellow, and white—had assumed the distinguishing marks by which they are still known. And, no sooner do we meet with evidence of racial diversity, than we begin to discover indications of race intermixture. The ancient Egyptians, who furnish us with such interesting examples of the human varieties of their time, were themselves a people of mixed blood. Nor in that respect were they singular. If, starting from that meeting-place of nations and tongues, the Nile Delta, we traverse the adjacent continents to their utmost limits, everywhere on the route, from Aino-peopled Japan to the Pillars of Hercules, we shall be confronted by the testimonies of interfusion of blood. Even races that seem most homogeneous, like the Chinese, or that have taken pride in avoiding the taint of alien mixture, like the Aryan Hindoos, or, like the Israelites, deemed themselves interdicted by the Divine command from intercourse with foreigners, have been proved beyond a doubt to be of composite origin. To deal separately with those various families of mankind as the dawn of history discloses them to us, or as the centuries of its short range have left them, would take up much time. The general result is, however, well set forth in a passage which I may be permitted to quote from "The Human Species" of M. de Quatrefages. "In China, and especially in Japan," says that distinguished ethnologist, "the white allophylian blood is mixed with the yellow blood in different proportions; the white Semitic blood has penetrated into the heart of Africa; the negro and Houzouana types have mutually penetrated each other and produced all the Caffre populations situated west of the Zooloos of Arabian origin; the Malay races are the result of the amalgamation, in different proportions, of whites, yellows, and blacks; the Malays proper, far from constituting a species, as polygenists consider them, are only one population, in which, under the influence of Islamism, these various elements have been more completely fused. I have

* "Who was Primitive Man?" in "The Fortnightly Review," and "The Popular Science Monthly," November, 1882.

quoted at random the various preceding examples, to show how the most extreme types of mankind have contributed to form a certain number of races. Need I insist upon the mixtures which have been accomplished between the secondary types derived from the first? In Europe what population can pretend to purity of blood? The Basques themselves, who apparently ought to be well protected by their country, institutions, and language, against the invasion of foreign blood, show upon certain points, in the heart of their mountains, the evident traces of the juxtaposition and fusion of very different races. As for the other nations, ranging from Lapland to the Mediterranean, classical history, although it does not go back for a great distance in point of time, is a sufficient proof that crossings are the inevitable result of invasions, wars, and political and social events. Asia presents, as we know, the same spectacle; and, in the heart of Africa, the Gagas, playing the part of the horde of Genghis-Khan, have mixed together the African tribes from one ocean to the other." *

Turning now from the past to the present, let us briefly inquire whether, where, and to what extent the intercrossing of the human races is going on in our own generation. And let us begin with our own hemisphere.

In a recent article in this magazine,† Professor Rudolph Virchow directed attention to what he terms "a delicate ethnological problem" —"the peculiar physiology of the Yankee." "That type," he says, "is not wholly comparable either with the English or the German, or with a cross of the two with the Irish race." He implies, rather than asserts, that its distinctive features are due to the transforming influence of climate, nor does he hint that it might be the result of a tinge of aboriginal blood. In another portion of the same paper he expresses the belief that, however mixed, the population of the United States must remain Aryan at bottom, heterogeneous elements being absorbed without leaving a trace. The problem is certainly interesting, even if we have regard merely to the stage of development that has been reached, and study American characteristics as compared with those of any of the European races that have had a share in the making of the nation. But its interest is intensified when we survey the scattered groups—white and black and red and yellow—whose amalgamation into one vast community may be the work of years to come.

The opinion prevails that north of the Gulf of Mexico the fusion of European and Indian blood has hitherto been extremely rare. Dr. Daniel Wilson believes, on the other hand, that, to a great extent, what has been taken for the extinction of the Indians has been simply their absorption, and that "they are disappearing as a race, in part at least, by the same process by which the German, the Swede,

* "The Human Species" ("International Scientific Series"), pp. 273, 274.

† "Acclimatization," in "The Popular Science Monthly," February, 1886.

the Irishman or Frenchman, on emigrating to America, becomes, in a generation or two, amalgamated with the general stock."* Nor is it on the frontier settlements alone that he has observed the evidences of such interfusion. "I have recognized," he says, "the semi-Indian features in the gay assemblies at a Canadian Governor's reception, in the halls of the Legislature, among the undergraduates of Canadian universities, and mingling in selectest social circles." Dr. Wilson says, moreover, that "in Lower Canada half-breeds, and men and wommen of partial Indian blood, are constantly met with in all ranks of life," and cites with approval the opinion that "in the neighborhood of Quebec, in the Ottawa Valley, and to a great extent about Montreal, there is hardly among the original settlers a family in the lower ranks, and not many in the higher, who have not some traces of Indian blood."

M. Benjamin Sulte, on the contrary, indignantly denies that the early Canadians intermarried (except in rare instances) with the Indian tribes.† On this point, Abbé Tanguay, than whom no one should be better fitted to pronounce judgment on such a question, makes the following remarks : "For many years the proportion of women to the male immigrants was extremely small. The Carignan regiment alone added fifteen hundred to the population. Did those young soldiers marry native women, and are we to reckon the latter among our ancestors? Some of the colonists did certainly marry native girls, but those girls had been educated and civilized in the institutions of the Hôtel-Dieu and the Ursulines. We can cite several of the most respectable families in Canada who number among their progenitors the sons of the forest, and who should be proud to do so. Among others may be mentioned that of the late Commander Jacques Viger, one of whose ancestors was a daughter of Arontio, the disciple of Father Brebœuf, and like him a martyr to the faith. Nevertheless, we must regard such alliances as exceptional." ‡

In the foregoing quotation Abbé Tanguay indicates the cause to which, in frontier settlements, the union of whites and squaws is mainly to be attributed—the dearth of white women. It was under the stress of such a famine that the half-breed population of the Canadian Northwest, which has of late been so much before the world, grew to its present proportions. Its history carries us back to near the beginning of the eighteenth century. Arthur Dobbs, whose account of the countries adjacent to Hudson Bay was published in 1744, obtained his information almost wholly from a half-breed trader called La France—a proof that the *métis* was not unknown a century and a half ago. The explorations of the Verandryes, father and sons, lasted from 1731

* "Prehistoric Man," vol. ii, pp. 250–253.

† "Histoire des Canadiens-Français," vol. i, p. 154.

‡ "Les Familles Canadiennes," in "Transactions of the Royal Society of Canada," vol. i, section i, p. 43.

to 1754. After the conquest of Canada by England, the fur-trade ceased for some years; but in 1766 the Montrealers began to push northwestward, and from that time their agents, mostly French-Canadians, mingled freely with the Indians—the consequence being the growth of a half-breed community. There was a considerable population, known by their chosen designation of *Bois Brulés* (for which they sometimes substituted the more ambitious style of "the new nation"), when Lord Selkirk began his scheme of colonization in 1811. That even then they were not all French is shown by some of their surnames being Scotch or English. But it is from the years immediately following the establishment of the Red River Colony that the bulk of the English-speaking half-breeds date their first appearance. In the year 1814 they numbered two hundred. In 1870 the Manitoba half-breeds and *métis* (as those of British and French origin may be distinguished) were estimated at ten thousand. Besides them, there was a population of uncertain number scattered through the Territories, and a tribe of half-breed hunters which one early explorer deemed to be six thousand strong. In 1874 Dr. G. M. Dawson, while engaged in the British North American Boundary Commission, came upon the camp of the latter body, consisting of two hundred buffalo-skin tents and two thousand horses.* Dr. Wilson considers the rise in this way of an independent tribe of half-breeds as "one of the most remarkable phenomena connected with the grand ethnological experiment which has been in progress on the North American Continent for the last three centuries." The half-breeds, who were given to the chase, have been credited with courage, discipline, and self-control. Those of French paternity are said to be more lively and frank, and physically stronger; those of British origin, the more stable and industrious. The Rev. Professor Bryce, of Winnipeg, says that "like all savage races, the *Bois Brulés* are fickle. They must be appealed to by flattery, by threats, or by working upon their animosities or well-known dislikes, if they would be led in any particular direction"†—and the truth of this characterization was painfully exemplified in the recent rebellion under Riel, no less than in the sanguinary conflict into which they were seduced in 1816. Now that the force of circumstances has subjected them to the restraints of civilization, the likelihood is that they will eventually become merged in the dominant race. Some of them have proved themselves well able to compete with white rivals for the prizes of life. A few of them have achieved success, not only in business and the professions, but in the more trying arena of politics; and, at the very time when the unfortunate Riel was expiating his crimes on the scaffold, a more worthy sharer in the blood

* "Report of the Geology and Resources of the Region in the Vicinity of the Forty-ninth Parallel, from the Lake of the Woods to the Rocky Mountains," etc. (British North American Boundary Commission.) By G. M. Dawson, pp. 295, 296.

† "Manitoba: its Infancy, Growth, and Present Condition," p. 204.

which gave him his ill-omened influence was Prime Minister of Manitoba.

Is there not some reason to believe that the seemingly episodic phenomenon which we have been contemplating is exceptional in degree rather than in kind; and that, much oftener than has been vulgarly supposed, in the advance westward of the American pioneer, he has made the dusky belle of the wigwam the partner in his toils and the mother of his children? For several reasons, some of them obvious enough, records of such unions are not easily obtainable. In census returns, one origin only is given. A person may choose to be set down as of European or Indian extraction, but he can not have paternity and maternity both specified; and, as to any remoter pedigree, the inquirer is left entirely in the dark. It is only in those rare cases where a half-breed has obtained prominence or notoriety, and comes to have his biography written, that the student of ethnology is enabled to add another to his repertory of instances. But, if the inquirer had only leisure and means enough to visit the border-lands of promise, he would be almost sure to glean facts that would surprise the incredulous. Miss Theodora R. Jenness, in telling her experience of a brief stay in the Indian Territory, makes frequent mention of mixed marriages and of the offspring thence resulting. Of well-behaved whites who wandered thither in search of fortune, she writes, "If a man goes there unmarried, he is apt to find a help-meet in an Indian maiden, there being many among the Cherokees and Choctaws who, for beauty and intelligence, compare favorably with any ladies in the States."* She describes the upshot of a law passed in one of the Indian councils requiring all single white men to leave the colony, as "a lively skirmish after wives by bachelors and widowers whose business interests required them to remain." That the ladies who were, like Barkis, willing, were not unworthy of their suitors, Miss Jenness is quite assured. The fair Choctaw, who explained the *ruse* to her, she characterizes as "a sprightly lady, whose charming face and perfect grace would render her an ornament in any society of Boston or New York." In the distribution of cultivated lands among the Cherokees we find fifteen hundred acres allotted to the full-bloods, three thousand to those of mixed blood, and twelve thousand to the whites; but from these figures we can only conjecture the relative number of each category. It is evident, however, that the half-breeds are an appreciable element in the community. Among them allusion is made to the grand-niece of a commodore and niece of a senator, to whom Miss Jenness was introduced by "a blue-eyed Indian girl who taught languages, philosophy, and the higher mathematics," but had forgotten the use of her mother-tongue. The names of Ross, Adair, and Boudinot among the Cherokees, and of McIntosh, Grayson, Porter, and Stidham, among the Creeks, prepare us for the announcement that

* "Atlantic Monthly," April, 1879.

the bearers of them are of mixed lineage. They all hold positions of honor in their respective nations, and their peers among the Choctaws and Chickasaws were likewise of twofold origin. "This harmonious blending of the two races, it seems to me," comments Miss Jenness, "is the great solution of the Indian question as regards the five civilized tribes, which with the rising generation will do away with prejudice, and establish peace and good-will between the whites and Indians." That humane hope would be more reasonable if the artificial barriers which keep the races apart could only be removed; but half-breeds that remain amid Indian surroundings and influences, however cultured they may be, are sadly tempted to relapse into the habits of savage life. It is only when the bride is carried far away from her father's house and people that she and her children form lasting ties of affection with their white kindred. Then, like some of the descendants of Pocahontas, they may reflect credit on both sides of their ancestry. Miss Jenness's narrative indicates, however, in what way and to what extent the blood of both whites and Indians may have been modified in the course of forgotten generations.

A good deal has recently been written on the negro's destiny in the United States. Slavery is of the past, but it has left its Nemesis behind, and the problem calls urgently for solution. Some of the more philanthropic of the *ante-bellum* abolitionists did not hesitate to counsel amalgamation as the true key to it. The late Wendell Phillips, in one of his outbursts of eloquence, spoke of that "sublime mingling of the races which is God's own method of civilizing and elevating the world." Bishop Haven felt confident that Americans would one day see "Helen's beauty in a brow of Egypt." The Rev. George Rawlinson, the historian, is also in favor of race-fusion. But Bishop Dudley, who has had opportunities of looking at the question from a nearer point of view, thinks that, in their actual condition, union with the blacks would be ruinous to the whites. And yet, what he can not accept as a doctrine for the present may, he admits, be received by generations still unborn as in the natural course of things. "What may come," he writes, "in the far-distant future, when by long contact with the superior race the negro shall have been developed to a higher stage, none can tell. For my own part, believing, as I do, that 'God has made of one blood all the nations of men,' I look for the day when race peculiarities shall be terminated, when the unity of the race shall be manifested. I can find no reason to believe that the great races, into which humanity is divided, shall remain forever distinct, with their race-marks of color and of form. Centuries hence, the red man, the yellow, the white, and the black may all have ceased to exist as such, and in America be found the race combining the bloods of them all; but it must be centuries hence. Instinct and reason, philosophy, science, and revelation, all alike cry out against the degradation of the race by the free commingling of the tribe which is highest with that which is lowest in the scale of development."*

But such commingling seldom, if ever, takes place from deliberate choice on the part of the reciprocating races; nor, indeed, are many marriages the result of calculation regarding their issue. If, early or late, the nations of the United States are destined to coalesce, the coalition will come about not with observation, but through the gradual and almost imperceptible obsolescence of prejudices.

There is one point which, in dealing with the subject of miscegenation on this continent, has hitherto received meager attention—the diversity of the stocks from which the African emigration to America has been derived.† Some of them were more distinct from others than the Spaniard from the Norwegian or the German from the Italian. With several of them there came, no doubt, a considerable share of darkened Semitic blood, while others could claim kindred with races that had won power and renown while Europe was yet in barbarism. Apart from any consideration of white admixture, there has, therefore, been an interblending of dusky tribes which must have materially modified Africa's contribution to the population. As for the more serious question of its relations to the Aryan element there is, as already intimated, difference of opinion. According to the census of 1880, the colored population of the United States was 6,577,497, that of the whites being 43,402,408. During the ten years from 1870 to 1880 the ratio of increase in the former (34·8 per cent) was larger than it had been during any decade except one, that from 1800 to 1810. The fact that the ratio of increase of the white population during the period from 1870 to 1880 was only 29·2 per cent, according to the census, naturally occasioned comment and even alarm. In "The Popular Science Monthly" for February, 1883, Professor E. W. Gilliam, in an article on the subject, based on the statistics of the last two censuses, maintained that the colored people were increasing at a rate which, unless prompt measures were taken to prevent it, would result in the inhabitants of the country becoming Africanized. Mr. Henry Gannett, in a recent contribution to the same journal, disputes the data on which Professor Gilliam founded his argument, and denies that the negroes, either in the cotton States or in the country at large, are increasing so rapidly as the whites, and holds that the fear entertained of the latter being ultimately outnumbered is entirely groundless. Nevertheless, even if the colored people were pretty evenly dispersed through the States, the proportion is large enough to cause uneasiness to those who think that their absorption would not improve the nation. As it is, while, since the close of the war, the tend-

* "How shall we help the Negro?" in "The Century," June, 1885.

† On this point see "The Dance in Place Congo," by George W. Cable, in "The Century," February, 1886; and "Race and the Solid South," by Cassius M. Clay, in the "North American Review," same month.

ency has been rather to drift apart, there has, on the other hand, been no strong inclination on the part of the freedmen to abandon the South. What Mr. Cable calls the "vast, vague afrite of amalgamation," which was once a real power in the land, seems, through the repulsion born of conflict and changed relations, to have lost its potency for either good or evil. Mr. Cable accounts for its absence in the North by insisting that the Northerners were guided not by instinct, but by "the better dictates of reason and the ordinary natural preferences of like for like." * Has the reign of reason begun in the South also? Or, as political antipathies grow feeble, will the Caucasian fastidiousness that grew strong with them also languish and fade? At any rate, some of the best men in the South, as in the North, are standing out courageously for the removal of all degrading disabilities from the colored people, and freeing them from the bondage of restrictions that debase them in their own eyes and in the eyes of the world. If Bishop Dudley's vision of the future be prophetic, and the day be coming, though still far off, when there shall be no more, except as occasional visitants from other lands, either white or black, or red or yellow, within the enlarged confines of the world's great republic, then it is only reasonable that the forefathers of the race that is to be should be at liberty to make what alliances please or suit them without being called to account for doing so. There is little danger of the transformation taking place too rapidly, but no excommunications will retard it, if it is to be. As the Hon. Cassius M. Clay says on this very subject, "Here, as elsewhere, we rest upon the survival of the fittest, and we shall see what we shall see."

The presence of the Chinese on this continent adds still further to the complications of the race problem. That, where they obtain a hold in a white community, intermarriage ensues has been shown by the recent census of Victoria, Australia, where one hundred and sixty persons were returned as half-castes. In the report of the commission appointed by the Canadian Government for the purpose of inquiring into the whole subject of Chinese immigration, Dr. Stout, of San Francisco, testifies that such unions had taken place there. Whether the measures adopted for the exclusion of the Chinese will permanently arrest the incoming tide is very doubtful. That the superfluous hordes of Mongols and Tartars will once more cross the limits of race and invade, with force resistless, the strongholds of Western civilization, is the belief of men who are far from being mere dreamers. Though that deluge may not come in our day, plain forewarnings of its approach are not wanting. China has already entered on the path of railway enterprise, and, when the extension of means of communication shall have shortened the overland route to Europe, the drama of Attila may be re-enacted in a new form.

* "The Silent South" in "The Century," September, 1885.

M. de Quatrefages sets down the proportion of mixed blood in Mexico and South America at one fifth of the whole population. The "Statesman's Year-Book" for 1886 makes it much larger. In Mexico, with a population of over ten million, it is calculated that not more than twenty per cent are of pure European descent, while those classified as Indian number above three million and three quarters. In Guatemala, Honduras, Nicaragua, San Salvador, and Costa Rica, the vast majority of the people are Indians and *mestizos*, so that, if the scheme of Barrios had succeeded, he would have practically ruled over a federation of half-breeds. In the society of the cities only a mere sprinkling pretends to pure Spanish descent. In South America the mixed races are still more numerous in comparison with the rest of the population. In Brazil the colored slave or freedman element has mixed with both creoles and Indians. In Hayti and San Domingo the blacks are the ruling race. In Venezuela whites and blacks have coalesced with Indians to such an extent that, with the exception of about a thirtieth part of the population made up of savage aborigines, the great bulk of the nation is mixed. In Peru it is expected that before long the country will have reverted to the aboriginal condition, only about two per cent of the inhabitants remaining unaffected by Indian or negro admixture. Though in some South American states, such as Chili and the Argentine Confederation, immigration tends to keep up the supply of European blood, in no case is it in the ascendant.

M. d'Omalius has reckoned the number of half-breeds in the world at eighteen million, his computation taking account only of the products of crossing of the European and colored races. But, if what has been said of the proportion of half-breeds to the entire inhabitants of the New World alone be correct, it comes far short of the reality. For obvious reasons it would be difficult to obtain trustworthy statistics concerning the distribution of pure and mixed blood in a community where mixture is a mark of inferiority. Half-breeds, fair enough to pass for whites, would not be likely to volunteer the correction of misconception as to their origin. The degree of dark admixture is, therefore, more likely to be understated than overstated.

While this continent offers to the inquirer the most interesting and numerous examples of new ethnic varieties created by intercourse between different races, others to be found elsewhere are well worthy of attention. In the Sandwich Islands there are the offspring of natives and foreigners of almost every nationality from English to Chinese. Some of the Hawaiian-British half-castes are intelligent, well-conducted, and industrious. The ruler of the kingdom, who recently traveled through Europe, is an accomplished gentleman, as well as a statesman-like and progressive prince. When it is recalled that little more than half a century ago the Hawaiian group was peopled by savages, meet descendants of Captain Cook's murderers, the present condition of the kingdom, with its educated and law-abiding citizens, is one of the most striking testimonies that modern history affords to the benefits which the dark places of the world have derived from well-directed missionary labor. Tahiti, the capital of which is described as a miniature Polynesian Paris, is another instance of successful missionary and colonizing enterprise, and equally remarkable has been the transformation which the establishment of British rule has effected in Feejee. Unhappily, the contact of even the best civilization with aboriginal races is not always a boon to the latter. The Maoris, one of the finest of the dark-skinned occupants of Polynesia, have dwindled away in the hopeless struggle with an aggression which they were not strong enough to resist and were too proud to conciliate. Neither in their native New Zealand, nor in the lost heritage of the far inferior Australians, has a half-breed population sufficiently large to affect the destiny of the colonies as yet sprung up. To what extent the presence of convicts in New Caledonia has affected the half-breed problem, a writer in "L'Expansion Coloniale" gives us some means of judging. M. P. Joppicourt, in a clever contribution to that journal, presents a striking though melancholy picture of the *popinées*, or native companions of the French settlers or pardoned criminals. While the rare Frenchwomen, who have ventured to share the discomforts and perils of such an exile, are petted and courted in Noumea (the capital of New Caledonia), away off in the bush the poor, faithful *popinée* hugs with rapture the white man's child of which she is the proud and loving mother. She looks upon her husband as her master, and does homage to her offspring as of a superior race. For their sake she has severed herself from her tribe, and refrains from the use of her own language, lest her little ones should be thereby degraded. Her kindred have turned against her as a renegade, but she minds not their reproaches. Alas! a day comes when they have their revenge, when the white man closes his door against her and bids her begone. She has served his purpose, and he needs her no longer. He is paying suit to a countrywoman of his own, and the *popinée* must get out of the way. And so, with misery in her heart, she betakes herself with her children back to the tribe, where for a long time she must put up with taunts and every humiliation. But she, too, has her revenge. By-and-by love changes to bitterness, and his children learn to hate the name and race of the father who has disowned them. When the cry of war is raised, they are the most eager to sink their battle-axes in the white man's skull, to burn his farm, to massacre his wife and children. And thus the innocent and good pay with their lives for the craven treachery of a heartless wretch. Let us hope that the picture is not representative, but exceptional. The same writer seems to see in the half-breed some ground of hope for the future of a colony avoided by the luxurious ladies of France. "Has not South America," he asks, "been entirely peopled by the crossing of Spaniards and Indians? Yes: those *mestizos* have formed powerful and respectable nations. And in North America, too, it was by allying themselves with the willing daughters of the Abenakis that the sons of France created that vigorous Acadian stock whose patriotic spirit has more than once kept at bay the proud rulers of Old and New England. 'What a pity,' said the Indians after the capitulation of Quebec, 'that the French were conquered! Their young men used to marry our daughters.' Those mixed marriages gave us faithful allies, and enabled our colonists, abandoned by the mother-country, to make head for a century against the inexhaustible forces of Great Britain." * In like manner may the *popinée*, he thinks, prove the main-stay of France in the Pacific.

There is no more romantic and extraordinary instance of a new human variety starting into life, and, in spite of deplorable beginnings, taking on the better characteristics of the wild and the civilized race, than that of the Pitcairn-Islanders. The story is well known, and I need scarcely repeat it. It may suffice to say that, after the tragedy of the Bounty, the refugee mutineers, nine English sailors, accompanied by six men and fifteen women of Tahiti, settled on that little secluded islet. By feuds of race the colony was reduced in four years to four white men and ten Tahitian women. A few years later, Adams, the pious patriarch of the community, was the sole survivor of the repentant mutineers. But, meanwhile, children had been born, who grew up and married and had families, and in 1830 the population of the island was eighty-seven. Some of them were then transferred, at their own desire, to Otaheite, but they had been religiously trained, and the loose morals prevalent there disgusted them. So most of them returned home within the year. In 1856 a second experiment at emigration was made, Pitcairn proving too small to support the rapidly growing population. But Norfolk Island was nearly as distasteful to the half-breeds as Otaheite had been, and in a few years they had almost all come back. When Admiral de Horsey visited the colony in 1878, he found sixteen men, nineteen women, twenty-five boys, and thirty girls—in about sixteen families. At that time the elected governor was James Russell McCay, steersman of the island whale-boat, of which he was also the builder. The law of the land was the simple, but morally rigorous, code drawn up by Adams. The colony, as the admiral described it, was a community of contented, friendly, gentle, pious people, poor but happy, strict in attending to their religious duties, and taking their recreation mainly in the form of music, most of them being good singers. A later visit to Pitcairn of an English vessel was some time ago described in the London "Daily Telegraph."

The communities of half-breeds to which I have been directing attention are mainly composed of English, French, or Spanish, blended

* I would like to know where M. Joppicourt obtained his information concerning the frequency of mixed marriages in Canada under the old *régime*.

with some colored race. The Portuguese, like their neo-Latin kinsmen, have ever been known to mingle their blood with that of aliens in all parts of the world. In Brazil, on this continent, they are largely represented in combination with both the Indian and the negro, while instances are not wanting in which the blood of the three is blended in various proportions. In Africa the same people has mixed with the natives of both the east and west coasts. In Asia, though none of their colonies are large, compared with those of England, their position was one of influence before the stream of exploration had drawn other nationalities eastward. The Malay word *mandarin*, so associated in our minds with the despotic system of the extreme Orient, was one of the prizes of early Portuguese exploration, and it is one of several terms and phrases which the daring countrymen of Camoëns have, by origination or adaptation, caused to pass current in the whole world of commerce and diplomacy. Even in lands where their influence has waned, the vestiges of their former power remain in the language of the people. On landing at Batavia in the autumn of 1878, Mr. H. O. Forbes heard here and there, amid the Babel of foreign tongues that assailed his ears, "a Portuguese word still recognizable, even after the changes of many centuries, veritable fossils imbedded in the language of a race, where now no recollection or knowledge of the peoples who left them exists." And at a later date, while visiting the shops and offices of Dilley, in Timor, he was astonished "to find all business conducted, not as in the Dutch possessions, in the *lingua franca* of the Archipelago, Malay, but in Portuguese." * Where the Portuguese have imposed their language, it is only to be expected that they have to some extent mingled their blood with that of the people who speak it. In Goa, Hindostan, Macao, China, famous from its association with Camoëns, and in the scattered insular possessions of Portugal, as well as in other parts of the East, there is a considerable population of Portuguese half-castes. Among the six millions of the Philippines, Spanish *mestizos* are also numerous. In Manila, the capital, they form a considerable proportion of its population of one hundred and eighty thousand. Of people of Dutch mixed with native blood there must be a good many in the Dutch East Indies. The Griquas of South Africa form, however, the most interesting example of a Dutch half-breed community. In Japan there is also a population of partially Dutch descent. Intermarriage between the ruling and the subject race in Hindostan, though not so frequent as it would be in like circumstances if any of the neo-Latin races held the position of the English, is by no means unknown, nor, where the social conditions are on a par, is there any degradation attached to it. Ceylon furnishes many examples of mixed blood, the European element being Dutch, Portuguese, or English. The extent to which the East and West have amalgamated west of the Arabian Sea it is impossible to say, but, if

* "A Naturalist's Wanderings in the Eastern Archipelago," pp. 6, 417.

the truth were known, it would, perhaps, surprise the sticklers for Caucasian exclusiveness. Travelers are constantly meeting with Europeans of almost every nation in out-of-the-way corners of the world, where they have made themselves homes and taken them wives of the daughters of the land. When in 1836 the late Charles Darwin and Captain (afterward Vice-Admiral) Fitz-Roy visited the Cocos-Keeling group in the Indian Ocean, they were surprised to find that Mr. J. C. Ross, with a *familia* of Orientals, had taken up his abode in those lonely islets. Yet Mr. Ross himself had been no less surprised to discover that another adventurer, Mr. Alexander Hare, had anticipated him. When Mr. H. O. Forbes visited the islands in 1878, he found Mr. Ross's grandson still in possession and quite happy in his self-imposed exile from civilization. The inhabitants on the last occasion were found to be nearly all of mixed blood, the proprietor himself having married a Cocos-born wife.*

If it would not tend to prolong this essay indefinitely, many more instances might be recorded. There is hardly a portion of the East in which abundant evidence is not obtainable of the mixture of race already accomplished or now going on. The Malay Peninsula, Burmah, Siam, Cochin-China, Hong-Kong, the seaport cities of China and Japan, besides the countries already mentioned or alluded to, furnish testimony to the fact enough to satisfy all who seek information on the subject. The following picture of the racial variety to be met with in an Eastern city shows, at least, what opportunities exist for intermixture: "The city is all ablaze with color. I can hardly recall the pallid race which lives in our dim, pale islands, and is costumed in our hideous clothes. Every costume from Arabia to China floats through the streets: robes of silk, satin, broadcloth, and muslin; and Parsees in spotless white, Jews and Arabs in dark, rich colors—Klings (natives of Southern India) in crimson and white, Bombay merchants in turbans of large size—and crimson cummerbunds. Malays in red sarongs, Sikhs in pure white, their great height rendered almost colossal by the classic arrangement of their draperies, and Chinamen from the coolie, in his blue or brown cotton, to the wealthy merchant in his frothy silk *crêpe* and rich, brocaded silk—made up a medley irresistibly fascinating to the stranger." † Such is Singapore, and not far off is Malacca, one of the oldest European towns in the East, originally Portuguese, then Dutch, and now, though nominally under English rule, practically a Chinese colony. Not less striking is Mr. Forbes's sketch of a street-scene in the capital of Portuguese Timor: "Tall, erect indigenes mingle with negroes from the Portuguese possession of Mozambique and the coasts of Africa, most of them here in the capacity of soldiers or condemned criminals; tall, lithe East Indians from Goa and its neighborhood; Chinese and Bugis of Macassar, with

* "A Naturalist's Wanderings," etc., pp. 13–20.

† Isabella Bird, in the "Leisure Hour."

Arabs and Malays and natives from Allor, Savu, Roti, and Flores; besides a crowd in whose veins the degree of commingledness of blood of all these races would defy the acutest computation."* The Timorese themselves represent the Malay, the Papuan, and the Polynesian races. But they also offer exceptions which can not fail to strike the beholder with wonder. For instance, the same author writes: "While in the act of turning from watching this human hunt to continue my journey, my eye lighted on an object that riveted my interest more than all else among those savage marketers—a red-haired youth, first one, then a few others, some with straight, some with curly hair, with red eyelashes, blue eyes, and the hair over their body also reddish. I found, on inquiry, that a little colony of them, well known for their peculiar color of hair and eyes, lived at Aitûha, at no great distance off. Though they lived in a colony together, they were not shunned by their neighbors, who even intermarried with them. The offspring of these unions took sometimes after the one, sometimes after the other parent. In looking eagerly at their faces, I saw more than their features only; their presence there was an excerpt out of a long history. In imagination I saw past them down the dim avenues of Time —a far, far cry—to their early progenitors, and pictured their weary retreat, full of strange and romantic vicissitudes from a more northern clime, till forced off the mainland by superior might into exile in this remote isle, where, as a surviving remnant amid its central heights, they are living united, but not incorporated with the surrounding race whose pedigree has no link in common with their own." †

Space will not permit me to more than allude to the race-mixtures of Hindostan and its border-lands, of the Afghan frontier uplands, where Mongoloid and Caucasian still contend for the mastery,‡ of the important region once swayed by the scepter of Darius, of the lands of the Sultan, of the many-tongued realm of the Czar, and the long, deep range of Arab conquest in Africa.

Of what blood-fusion did for that part of the world, the broad seat of successive empires in the distant past, I have already briefly spoken. And the transformation is still going on. The sons of Joktan and Ishmael, with the Koran in their hands, have been trying for ages to convert the dark tribes of Africa to the creed of the Moslem, and, in preaching their gospel, they have not disdained to share their ancient lineage with their dusky disciples. Arabic scholars have, by the cruel fortunes of the slave-hunt, found themselves enthralled to Brazilian

* "A Naturalist's Wanderings," etc., p. 418. † Ibid., pp. 464, 465.

‡ Mr. A. H. Keane ("Nature," January 8, 1885) divides the North-Afghan tribes into Caucasic and Mongolic; and, again, the former into Galchas and Iranians, and the latter into Mongols and Tartars. The Galchas are subdivided into Siah-Posh, Badakshi, Wakhi, and Shugnaris; the Iranians into Kohistani, Firuz-Khoi, Jemshidi, Tajiks, and Afghans. The Mongols are composed of Hazarahs and Airnaks, and the Tartars of Salor-Turkomans and Kataghani Uzbecks. The Caucasians number something over a million, and the Mongols over a million and a quarter.

half-breeds, their protests availing nothing against the evidence of their skins.* Whether the crusade inaugurated and sanctioned by the powers that constituted the Congo Free State will prove a more successful civilizer than the Arab's mission remains to be seen. If it fails to blanch the negro's skin, it may, and it is to be hoped that it will, liberate his mind from superstition and prejudice by its higher teaching and example.

SCIENCE IN RELIGIOUS EDUCATION.

By DANIEL GREENLEAF THOMPSON.

I.

THE interest of the community that its growing youth become good citizens, extending as it does almost to a necessity for self-preservation, has developed a system of public education, supported by taxation, like any other instrumentality of government. Besides this there are a great many institutions, particularly of a higher grade, which are of a private or perhaps semi-public character, maintained beyond tuition fees chiefly by individual gifts and bequests, but sometimes also by state aid in addition. Education in such schools of the one class and the other, rather than family education, it is the present purpose to consider with reference to the leading topic.

The maintenance of the social order depends upon the needs of mankind in this world; not upon their desires, their wants, their speculations regarding a life to come. To be sure the interests of men in the latter do influence their conduct in the present life and thus affect their character as citizens. Hence the religious creeds of its members are not matters of indifference to the community. At the same time the great heterogeneity of opinions and faiths makes it a perplexing question how to legislate for the common weal in such personal concerns as that of religion. But yet it may be urged with force that, if we waited for universal agreement before we taught anything, the instruction given in every department would be very scanty.

About all the higher studies, such as philosophy, psychology, political economy, and philosophy of history, would certainly have to be excluded, while in the ordinary branches of science there would be breaks wide enough to destroy continuity of teaching. Men, however, will often submit calmly to having their children taught erroneously in physics or psychology, while they are up in arms if heresies in religion are inculcated. Upon this latter subject there is extraordinary bitterness. What ought to be done under such circumstances?

First, with regard to schools supported by public moneys. Every one is taxed in this respect on equal principles of property-holding, not in proportion to the amount of his political, economical, or religious

* "Life in Brazil," by Thomas Ewbank, p. 439.

ideas that is to be propagated through the school system. But it is not in human nature that a man should like to see the state using his money to advance notions of which he disapproves. Particularly is this true of religious ideas. Shall his objection be heeded? Suppose a person be found who thinks it contrary to equity and good conscience that his children be taught the binomial theorem. Shall instruction in algebra, therefore, be stopped at this point? Or, shall the objector be forgiven his tax? Or, shall a school be instituted for his benefit where the obnoxious formula is left out? Will not the same argument, whatever it be, hold good for both religion and algebra alike?

The great purpose of education within the domain of the state is, I conceive, to make men of their own wills do what is right; that is, to act for the welfare of the whole organism. They will not so act unless they have the right disposition. Hence good character must be formed to insure good conduct. I do not suppose it will be seriously disputed that to accomplish this end, as regards knowledge, truth only should be taught. A character based on untruth or error is not desired by anybody. The controversy always is over the answer to the query of Pontius Pilate. As a discerning judge in one of the law reports remarks in an opinion: "There is no doubt that the plaintiff in this case ought by his contract to have beans: the question is, What *is* beans?" There is, perhaps, room for doubt whether *all* truth ought to be taught, even admitting it to be truth; but I shall assume that no one will urge that falsehood should be the basis of instruction to youth.

Theoretical knowledge may or may not have direct, appreciable effects upon character and conduct. A good deal of this sort of knowledge, when acquired in school education, is disciplinary for the purpose of exercising and training mental powers. Such is the case, for example, with the binomial theorem just instanced. Perhaps no great harm would result to anybody if it were left out of mathematical instruction in public institutions. But some disciplinary instruction there must be, and some one must decide what it shall be. Men are taxed for the support of schools on the theory that it is for the interest of the state that children be educated. Each one must leave to constituted authorities the power to prescribe in what this education shall consist; and even if he has views of his own, he can not be allowed to make their rejection by the school board just ground for refusing to pay his taxes. For similar reasons he can not ask to have a school established for his own ideas or for his own benefit. Besides, this last would be wholly impracticable on an extended scale. It would destroy the public-school system altogether. Nevertheless, nothing that is here said should prevent any one from agitating matters of complaint as to courses of instruction and enforcing his opinions if he can make them appear reasonable, through the regular channels of influence and authority.

Thus there must be a common order with regard to school instruction, overruling the preferences of individuals until changed by the common will regularly expressed. The question always paramount and fundamental is, then, What does the common interest demand? According to the tenor of our preceding remarks we might answer, Theoretical and practical truth. It would be commonplace to say that youth should be taught not to commit crimes or private wrongs. And further, in accordance with the principle of organic growth, they should be informed, clothed on, if possible, with the altruistic character. In the direct relations of man to man there is comparatively little dispute over what is theoretically right and what is wrong. As to the elementary virtues and vices there is no serious difference of opinion, unless concerning sex-relations, which need not be discussed here. So also as regards elementary knowledge in general. The multiplication-table is well settled, and is universally conceded to be of considerable practical utility. The right use of language might occasion more controversy, but there are standards which are tolerably decisive of disputes. The geography of the globe, the common features in natural history, the principles of mechanics, the ascertained truths of physics generally, can be and are taught without arousing animosity, although points of doubt, of imperfect knowledge, of opposition between authorities, are discovered. In these and like studies it is expected by all intelligent people, of whatever sect or party, that wherever there is question the doubt itself with the arguments for one side or the other will be stated. This is the course usually adopted. The best text-books follow this method. In no other manner can truth be taught. But in this way the learner can be put in possession of the exact state of knowledge in a given branch of study, or upon a certain topic; and if he have the requisite mental capacity, he is placed in the best possible situation also to add to that knowledge. This is obviously for the public interest. The things that are settled, indeed, should be so taught; but when there is dispute the utmost care should be taken to state impartially and accurately the divergent views.

Now, when we come to those departments of knowledge which involve important personal and social questions of practical consequence, respecting which there is contrariety of opinion, we have three courses open. The first is for the public authority to select one set of principles and precepts to the exclusion of others, and command these to be taught as truth, and these only; the second is to refrain from teaching anything whatever on the subject; the third, to adopt the method just mentioned, namely, to present to the learner the different opinions, with the grounds of each, in the most impartial and judicial manner.

If the first plan be adopted, the risk must be run of the doctrines selected not being true. Experience has shown that truth will out; and when once error is discovered, there comes both a demonstration of the insecurity of the method and a hearty contempt for it. The one who has suffered by the teaching feels himself defrauded and swindled. Unless we can reason ourselves into the belief that falsehood or error is sometimes useful, we shall have to seek some better procedure. And even if we could persuade ourselves of the utility of untruth, we should still have the very perplexing questions to answer as to when, where, and what sort of falsehoods are useful.

But this is not the end of the trouble. If there be difference of opinion, the parties whose doctrines are rejected will inevitably oppose, by every lawful means at least, the principles adopted by those in power. They will nullify school-teaching by home-teaching; they will seek to disturb the school system by overthrowing its government; they will encourage disrespect toward the whole scheme of instruction; they will be in a state of chronic rebellion, which will create a present and pervasive social disorganization outweighing any advantage to be derived from the authoritative teaching. For, even if the latter be the truth, and the other error, the chances are that the force of authority will develop so great a resistance as to give a formidable strength and vitality to the erroneous doctrine; whereas, if its power were not thus artificially gathered and its life thus supported, it would die out from its inherent insufficiency.

Nor yet is this the whole of the matter. The adoption of any assumed truths by authority in the face of a manifest difference of opinion is an oppression which leads directly to anarchy and revolution, with despotism to follow. In order to maintain the teaching, the pressure in support must continually be increased to overbalance the opposition, which nevertheless grows in this very process, until by-and-by an upheaval is inevitable, perhaps with ruinous devastation. This is a familiar historical experience of which I need not stop to give illustration. I desire only to recall attention to the fact that, in the social and political as well as in the physical world, every action has its reaction. Revolution and anarchy are the natural and inevitable consequences of the establishment of truth by command. It may not come immediately, but disintegration is all the while going on, and the results will sooner or later appear. Thus, taking all these considerations, and even omitting the more special arguments which flow from legal guarantees of individual rights as established in a free community, we may be sure that, upon broad principles of the common weal, the first of the three courses suggested for public schools, in regard to education upon disputed questions of practical moment to the individual and to society, must unfailingly be most pernicious.

The second plan, that of teaching nothing at all, is not for the highest public interest, because its effect is to prevent the young from giving attention to, and acquiring accurate knowledge upon, subjects which ultimately will be forced upon them, and will call for opinion or action. Substantially the same reasons prevail against this course which exist against a negative attitude of the state with regard to education generally. There are thinkers of eminence who believe that the state never should undertake to educate the young, leaving that work wholly to private agencies. Their position, I think, is an unsound one, because education is a necessity for security, and thus a legitimate matter of governmental cognizance. At all events, we have public systems, and, having them, it seems important that some instruction be given upon those topics which evidently take precedence of others in the minds of the people, and are of enough consequence to develop actively an opposition of opinion.

If this be so, there is only the third suggestion left, namely, to extend universally the scientific method of teaching. State the question fairly, give the facts bearing upon it accurately, explain impartially the differences of views with the reasons favoring each ; then let the individual form his own conclusions, entirely free from any of the arts of persuasion. This is the only method which subserves the public good, the welfare of the whole organism instead of the interest of a party, and which does not work injustice. Then the tax-payer can not complain ; or, if he does, it will clearly be because he is more desirous of serving his own particular idols, whether of personal creation or of party affiliation, than of promoting the cause of truth, in which alone lies the well-being of the community as a whole. The school which educates after this fashion is a powerful help to the stability of the commonwealth ; the teacher who thus teaches is a faithful and valuable public servant, for whose support no tax should be paid grudgingly.

While these remarks apply to the whole curriculum of instruction, the practical difficulty of giving such truly scientific instruction is often very great. There is little fairness between contestants ; and most people, even teachers, are partisans. Each seeks only to become the oppressor. Ascendency, conquest, domination, is dearer than truth. When this situation occurs, deplorable though it be, there is no alternative but to exclude rigidly all instruction upon the topic which is the subject of such anti-social striving. The first of our three propositions is intolerable ; the third and best may be impracticable ; then we must resort to the second, in the hope that better conditions may arise. As between the first two, in adopting the second, we are certainly choosing the minor evil.

This I conceive to be the wise practice to follow respecting public instruction, as based on that theory of society which holds that each individual is united in organic association with every other, being at once the means and end of all the rest. Now, with regard to religion, we are to-day in the position where we are obliged to consider seriously whether religious instruction shall be excluded wholly from public institutions, or be given scientifically and impartially. We can make no exception here to the rule that anything actively disputed by any considerable number of individuals in the community shall not be taught with authority in public institutions. There is not a single doctrine of Christian theology (save, perhaps, the altruistic law of self-abnegation as a rule of conduct) that is not doubted or controverted either within or without the aggregated Church. To begin with, there are two great irreconcilable bodies, the Catholic and the Protestant. Then there are the so-called atheists, the agnostics, the freethinkers. Again, there are multitudes of sects calling themselves Christian, but with differences upon expressions of supposed truth which they often regard as essential. Such being the case, for the sake of religious truth itself it would be unwise to have authoritative instruction given. In addition, there are all the reasons above cited, which militate so strongly against selecting a creed authoritatively out of the many that are put forward. Moreover, in communities like the American commonwealths, there are special reasons against such an adoption. It can not be done without contravening the organic law. Constitutional guarantees of religious freedom are in force in most of the States. For instance, the Constitution of the State of New York provides that "the free exercise and enjoyment of religious profession and worship, without discrimination or preference, shall forever be allowed in this State to all mankind." Mr. R. C. Spencer, one of the Visiting Board of the Wisconsin State Normal School, in an address before the school criticising the religious ceremonies he witnessed (1886), thus expresses the Wisconsin law: "Under the provisions of the Constitution of the State, this school can have no religious purposes. The State has no religious duties to perform; therefore this institution has none. Teachers of public schools and in public institutions have as such no religious duties. On the contrary, the moment the teacher in his capacity as such begins to exercise any religious function whatever, to exert any religious influence upon the minds of those under his instruction, that moment he infringes the reserved rights of the people." Not to multiply examples, under such fundamental law as this, the teaching in public institutions of any religious doctrines as conclusive truth in the face of dissent, is such a misapplication of the powers of government as to demand the most emphatic reprobation.

Must we, then, altogether dismiss religious instruction from public schools? Certainly no complete knowledge of the progress of human civilization can be obtained without including the influences of religion and religious institutions. It is really indispensable knowledge; and, if not gained in schools, must be secured elsewhere. It also involves questions of the gravest practical concern. Perhaps this kind of instruction belongs to higher institutions than those the state undertakes to maintain; though in a normal school, for the education of teachers, it is most directly pertinent. And generally in public schools of higher grade, those high enough, for example, to teach history, it would clearly be an advantage if some account of the leading religious ideas and the chief religious movements in the world's history were made the subject of instruction. The chief creeds of religion might even be taught, if the objections to them were given equal prominence with the points in their favor. I can not help thinking that a comparative study of articles of faith would be useful. Since, however, most of the religious sects would prefer nothing at all to be said unless their own system be inculcated as infallible, it appears that we must for the present keep out of courses of study all religious teaching. It is a pity that sectarian bitterness makes this necessary. If those who belong to religious parties would only allow consideration to those who differ from them; if they would cease to claim for themselves a monopoly of wisdom and divine favor, there would be no need of this exclusion. But if they insist that their creed be taught, and no other; if they refuse equality of representation of religious ideas; if they are determined that the deficiencies of their own notions be blinked while the defects of others are magnified: then, indeed, the sole course left is, to do the simple justice of absolutely excluding religious instruction.

The extreme difficulty of adopting the other course is evidenced by the strenuous insistance upon the one thing in connection with religion in schools which is most indefensible of all. I refer to worship. This amounts to inculcation of religious doctrine by insinuation. It is the jesuitical method, very potent indeed, but highly objectionable, because, without giving direct teaching, it operates to subtly instill religious creeds. It is neither open nor fair. Worship is something which belongs either to individual choice or to consentience. Those who agree in thought may unite in worship upon the basis of their agreement; otherwise it should be a personal matter. A form of worship implies the truth of the creed which it expresses or upon which it is based. What more dishonest and unworthy method of pre-empting and prejudicing the plastic minds of the young could possibly be devised than that of school worship? The solemnity of the exercise is impressed, all question and criticism are foreclosed, and then, under the sentiment of awe and respect for authority thus fully developed, beliefs are argued into the minds of children by prayer and collateral exercises.

So long as public-school worship is upheld, and the consciences of people are callous to its impropriety, it probably would be vain to expect the critical method of teaching to prevail. And yet in the present state of civilization it may not be a great while before it becomes feasible. A recent writer has asked, "Is there any reason why we should teach the life of Julius Cæsar in our schools and should not teach the life of Jesus Christ?" * I reply, there *ought* to be no reason, indeed, but there *is* one, which springs from the unreasonableness of those who urge religious teaching. That reason lies in the demand that the life of Jesus Christ be taught as the life in the flesh of a divine being, belief in whom is the sole salvation from eternal perdition. Granted,

* "Should the State teach Religion?" J. H. Seelye, "The Forum," July, 1886.

if you please, that this is true; it must also be admitted, deplored if you like, that a great many tax-payers do not believe its truth at all. But those who are represented by the writer quoted never would be willing to have the life of Jesus taught in the same manner as the life of Cæsar. They would not favor, for example, a fair setting forth of the arguments for and those against the miracles recorded in the gospels. They would be utterly horrified at any criticism of the character of Jesus. They would not allow him to be compared with Sakya-muni, as Cæsar might be compared with Alexander. The spirit in which they ask to have the life of Christ taught is that expressed by President Seelye in another part of the same article: "Why, then, on any consideration are not the gospels as proper a text-book in our schools as are Cæsar's 'Commentaries'? And if the teacher of the latter is to know them; if we make thorough inquiry respecting a teacher's qualifications for his task in other things, why not also here? If he does not, in the light of modern criticism, know that the story of the gospels is in the main true, he is ignorant; or if knowing its truth he would hide it, he is false; and in either case not fit to teach." There is an ambiguity in the expression "in the main true," which allows of wide differences. But no doubt the writer would intend to make his statement cover the miraculous events recorded in the gospels, certainly the story of the resurrection of Jesus. Now, upon this point it is to be feared that the ignorance lies on the side of the author cited. He says the historical accuracy of the gospels is "no longer doubted by intelligent persons." Who, having a tolerably large acquaintance of "intelligent persons," does not know that a considerable fraction of them disbelieve and a still larger fraction doubt the statements in the gospel record respecting the resurrection of Jesus? This is evidenced by journals, reviews, and even by religious organizations. If, now, a person who does not believe this account is not "intelligent" but is "ignorant" or "false" and "not fit to teach"; those who are fitted to teach the life of Jesus in the schools are only the ones who accept a particular "orthodox" view of Bible literature and are blind enough to be prevented from seeing intelligent difference of opinion! It is not the life of Jesus that a religious sect wants taught, but a particular theory of the life of Jesus. The Roman Catholics would like to have inculcated a similar theory of the Virgin Mary. How, under such circumstances, is it possible to teach the life of Jesus in the public schools? Until an agreement can be reached upon the platform of a thoroughly fair, critical instruction in religion, giving to believers and disbelievers alike the benefit of their views in equal degree, there is no other course open in a country of religious liberty than to interdict religious teaching in public institutions of learning.

Unless, indeed, we return to the rule of force. Listen to what President Seelye says, in concluding the article above quoted from: "Hence I say that the state should provide for instruction in the gospels for its own preservation. If the conscience of its subjects approve, well ; if not, the state will be cautious, but courageous also, and if it is wise it will not falter." It is difficult to believe that in these days of enlightenment any "intelligent person" can deliberately give utterance to a sentiment like this, which is only appropriate to the times of Cotton and Increase Mather. Can one fail on reading such records to have rise up in his mind the vision of the wicked and bloody Past ; the weary centuries of injustice, inhumanity, and woe ; the ceaseless succession of robberies, tortures, and murders "for Christ's sake"? Can it be that in this fair American land, "sweet land of liberty," "intelligent persons" are still found who do not see the absolute necessity, for the common freedom, that the state in its governmental office keep wholly aloof from any attempt to inculcate religion or religious doctrine by or with authority?

A plausible suggestion is often made to the effect that the public moneys should be divided among different sects according to their numbers, and used to promote sectarian teaching. This is said to be fair to the tax-payer, and satisfies the desire of those who wish religious teaching according to their own views. But such a plan does not fulfill the idea of state education. Aside from any difficulties as to division of moneys, which might perhaps be overcome, such a scheme would tend to prevent that very growth into organic unity which it is the object to secure. It makes for separatism, prepares the way for consolidation of each sect, and a struggle for supremacy between them. It is the interest of the state not to foster sectarianism, but to eliminate it or keep it strictly subordinate to the common freedom. The young must be brought up to the understanding that their prime allegiance is to the state, the community as a whole, not to any denomination, church, or party. When this is accomplished, private religious belief can be allowed to form itself as it may. But to divide public moneys in the way proposed is really to make the state the promoter of a sect, and to afford opportunity for the use of the public funds for the development of a character quite inconsistent with the public interests. Better have no state system of education at all, if we can not have one entirely free from sectarian control. It does not remove the difficulty that all sects are supposably to be treated equally. Organic development is what is wanted, not the separate nourishment of the different members independently. The public school ought to be a common well of pure water from which all may draw alike and unhindered ; and it should be kept free from anything that taints or colors it so that it may not be partaken of by all.

Protestants generally would indorse the foregoing sentiments with regard to the division of public moneys among sects ; but, strangely enough, they do not appear to see that their own claims give to the Roman Catholics the strongest case for their demands. The former are determined that the Bible shall be read in schools, with other exercises of worship, and that Protestant religious influences shall positively prevail. Such being their attitude, they can not consistently object to a division of the public moneys. They want sectarian teaching, but that of their own sect. This is what the Roman Catholics ask also. If these claims are strongly insisted upon, it seems that to divide the funds is not only just but the only thing that can be done in a free country, unless taxation for educational purposes be abandoned altogether. If Protestants desire the public-school system continued, they will be careful how they press the theory that the schools must be religious or under religious influences. On the ground which they ordinarily take, they have not the slightest right to oppose the division asked for by the Romanists. The only position from which these latter can be successfully resisted (I mean logically) is the platform of non-religious, or scientific teaching which has been above set forth.

[*To be continued.*]

THE HOUND OF THE PLAINS.

By ERNEST INGERSOLL.

A PICTURE of the Great Plains is incomplete without a coyote or two, hurrying furtively through the distance.

The coyote is a wolf—a wolf about two thirds the size of that one which haunts forests and the pages of story-books. He has a long, lean body; legs a trifle short, but sinewy and active; a head more foxy than wolfish, for the nose is long and pointed; the yellow eyes are set in spectacle-frames of black eyelids, and the hanging, tan-trimmed ears, may be erected, giving a well-merited air of alertness to their wearer; a tail—straight as a pointer's—also fox-like, for it is bushy beyond the ordinary lupine type, and a shaggy, large-maned, wind-ruffled, dust-gathering coat of dingy white, suffused with tawny brown, or often decidedly brindled:

> "A shade in the stubble, a ghost by the wall,
> Now leaping, now limping, now risking a fall;
> Top-eared and large-jointed, but ever alway
> A thoroughly vagabond outcast in gray."

Such is the coyote—*genus loci* of the plains; an Ishmaelite of the desert; a consort of rattlesnake and vulture; the tyrant of his inferiors; jackal to the puma; a bushwhacker upon the flanks of the buffalo armies; the pariah of his own race, and despised by mankind. Withal, he maintains himself and his tribe increases; he outstrips animals fleeter than himself; he foils those of far greater strength; he excels all his rivals in cunning and intelligence; he furnishes to the Indian not only a breed of domestic dogs, but in many canine races ranks as earliest progenitor; he becomes the center of myths, and finally is apotheosized.

Our coyote is a true Westerner, and typifies the independence, the unrestrained gayety and brisk zeal which enter into the heart of him who sights the Rocky Mountains. He is little known at present eastward of real bunch-grass plains. In early days, however, he was common enough in the open country of Arkansas, Missouri, Illinois, and northward, whence he received the name "prairie-wolf." Threading the passes, he wanders among the foot-hills of all the complicated mountain system that forms the "crest of the continent," and dwells plentifully in California valleys.

In the United States and British America, then, he is a creature of the open country, leaving high mountains and forests to the large, gray "mountain" or "timber" wolf (*Canis lupus*). Perhaps this is less his choice than his necessity, for in Mexico and Central America he seeks his food more often in forests than elsewhere, yet keeps his characteristic cunning and cowardice, becoming there a wild dog of the jungles, as, in the north, he is the hound of the plains. It is that tropical region, in fact, which gives us his name, for coyote is a pure Nahuatl word, with the final *e* softened into an *eh.* This ultimate must not be lost sight of in the pronunciation, which is coy-ó-té, not ki-yōt (or even kyoodle!), as often heard. Dr. D. G. Brinton writes me that the derivation seems to be from the root *coy*, which means a hole, and alludes to the earth-burrowing habits of the animal. I have met with a word of very similar sound, in a Californian language, said to mean "hill-dog."

When this wolf can not find a natural hollow to suit him, nor evict some unhappy hare, prairie-dog, or badger, he digs for himself a dry burrow, or perhaps a den among loose rocks. The *butte* districts of the upper Missouri and the lower Colorado valleys are, therefore, his strongholds. There the decay of sandstone strata, or the breakage due to volcanic eruptions and upheavals, give him the choice of a large number of crannies, while the desolation and remoteness of wide tracts, untenanted by men, afford him the seclusion he loves.

In such seclusion his young family of five to eight pups is brought forth during the latter part of spring, the date ranging earlier or later with the latitude, and the consequently varying advance of warm weather. It is during the weeks going just before and following immediately after the birth of the puppies that the old dog-coyotes work their hardest and most systematically. In hunting at this time, our wolf adds to his ordinary pertinacity and zeal, the sagacity and endurance necessary to turn his victims and drive them back as near as possible to his home, knowing that otherwise his mate and her weaklings will be unable to partake of the feast.

A remarkable picture of this was given some years ago, by a writer in an English magazine, who, in one of the best "animal chapters" it has ever been my fortune to read, detailed such a chase as witnessed by him in the grand forests near Lake Nicaragua. "Certainly," he exclaims at the conclusion of his account, "certainly no training could have bettered that dog's run. To drive a grown buck back to his starting-place, to send on a portion of the pack to that point where he would strive to break cover, to head him again and again into the cover where his speed could not be exerted to the full, were feats which might well puzzle all the best dogs in England, and the human intelligence which directs them."

His game and its getting are not always so noble as this, however, and the coyote knows well the pinch of famine, especially in winter. "The main object of his life seems to be the satisfying of a hunger which is always craving; and to this aim all his cunning, impudence, and audacity are mainly directed." Nothing comes amiss. Though by no means the swiftest-footed quadruped upon the plains, he runs down the deer, the pronghorn, and others, tiring them out by trickery and then overpowering them by force of numbers. The buffalo formerly afforded him an unfailing supply, in the shape of carrion or chance fragments left him by his Brahmans—the white wolves—who steadily followed the herds, and seized upon decrepit or aged stragglers, or upon any calves they were able to surround and pull down. In such piracy the coyotes themselves often engaged, though it tried their highest powers; and success followed a system of tireless worrying. The poor bison or elk, upon which they concentrated, might trample and gore half the pack, but the rest would "stay by him," and finally nag him to death. I remember once reading an account of the strategy by which a large stag was forced to succumb to a pack that had driven it upon the ice of a frozen lake. Part of the wolves formed a circle about the pond, within which the exhausted and slipping deer was chased round and round, by patrols frequently relieved, until, fainting with fatigue and loss of blood, the noble animal fell, to be torn to pieces in an instant.

Far less worthy game attracts this wild dog as well. In California and Mexico he has been so destructive to the sheep that incessant war is waged upon him by the ranchmen. In Kansas and Nebraska he is accused of making havoc among domestic poultry, suffering, no doubt, the discredit of many additional depredations by foxes, skunks, and weasels. Similar misdeeds were charged against him by the farmers of Illinois and Wisconsin, when, forty years ago, those prairies were the frontier. Two or three times a year, therefore, a general holiday would be declared, and a wolf-hunt would be organized.

Such a *battue* would take place just before the spring thawing. Word would be sent out, instructing the different villages concerned to elect their captains and furnish their quota of willing gunners in the ring that was to concentrate upon a point indicated by a tall flagstaff far out in the prairie. These rings were, sometimes, twenty or thirty miles in diameter, and it took an early start and rapid traveling to close up in time. The captains, on horseback, ride back and forth, keeping the line in order, watchful that everything is driven before it. After marching for a few miles, the different parties begin to come in sight of one another, all converging toward the central point. Glimpses of fleeing game, very likely including deer, or a wolf or two, are seen, and the orders "Hurry up! hurry up!" are more frequently heard. Finally the flag can be seen, and a little later the line of the opposite side of the circle comes into view. Now all nerves are strung to the highest pitch. There is a constant fusillade of shots as the thickening grouse soar up and backward over the line, or foxes and hares scud away from the shouting and yelling gunners. The captains, suddenly riding at top-speed to one side, shout: "Close up! close up! The deer will break!" Before it can be well done, a small band, following their leader like sheep, dart toward a vacant space in the rank of men. Half the deer get away in safety, but a few fall under the ready rifles, and one, stabbed by a bayonet, carries it and the gun twenty rods before dropping dead.

Soon word is passed to stop firing, for the circle is becoming dangerously contracted. Already one man has a bullet in his leg, and a captain's horse has been shot under him. Thus, in silence, the ring concentrates toward the flag-staff, which stands on the edge of a bowl-like depression. As the rim is attained, what a sight greets the eyes of the eager circle! With lolling tongues and staring eyes, a dozen tawny wolves are rushing up and down the shallow pit, seeking some chance of escape. But no mercy exists for the sneaking lamb-stealers. "Give it to them!" comes the order, and a hundred rifles pour instant death among the corraled victims. Then follow target-matches, trials of strength, races, and plentiful gingerbread, apple-turnovers, cider, and metheglin.

Tactics similar to those of coursing a stag on the ice, already mentioned, are furnished by the coyote when he fixes his heart upon a jack-rabbit. Alone, he could neither overtake nor surprise this vigilant and fleet-footed hare. Two wolves assist one another, therefore, one giving instant chase when a hare is started, while the other squats on his haunches. The runner turns the hare in a circle that brings it back near to the point of starting, where the second wolf is ready to keep it going, while the first rests. A few rounds use up the panting bunny. Then the wolf in chase bowls him over, and seeks to appropriate the whole of his not over-big carcass before the resting partner can claim his share, whereupon a row is very likely to result.

To capture the sage-hen and grouse, the coyote roughly quarters the ground, somewhat like a trained bird-dog, but with frequent crouching pauses, all the time wending his way toward the quarry. At the right moment he will drop flat in the grass and creep stealthily forward, as a cat would do, until near enough to make a fatal spring.

In fact, nothing eatable escapes this omnivorous prowler. It is the arch-enemy of such small deer as prairie-dogs and gophers, as well as of larger mammals; and, if no better food offers, it will revel in carrion of any sort. "It resorts in great numbers to the vicinity of settlements where offal is sure to be found, and surrounds the hunter's camp at night. It is well known to follow for days in the trail of a traveler's party, and each morning, just after camp is broken, it rushes in to claim whatever eatable refuse may have been left behind. But it can not always find a sufficiency of animal food. Particularly in the fall, it feeds extensively upon *tunas* which are the juicy, soft, scarlet fruit of various species of prickly pear (*Opuntia*); and in the winter, upon berries of various sorts, particularly those of the juniper."

Under the pangs of excessive hunger these small wolves are compelled to a furtive boldness they are incapable of under ordinary circumstances. Thus I have known them to come repeatedly within pistol-range of my camp-fire, in the mountains of Southern Colorado, and hunters tell me that they have been known to pull the boots or the leathern straps of a saddle from under the head of a sleeping camper. Sitgreaves records that when, for two days and nights, his party had kept possession of some solitary springs, in an arid part of Arizona, the coyotes became so desperate from thirst that they came to drink while men and mules were at the spring. As a rule, however, they are cowardly to the last degree, and trust to superior numbers and well-laid plans to effect their object. I remember at a place where I once encamped for two or three nights, in Southwestern Wyoming, that the rough ledge of a butte-face, just across the creek, was the home of a family of these wolves, and I often saw them, the mother lying at the mouth of their den, and the four whelps gleefully romping in the sunshine. The father of this family kept out of view at first, but later I caught sight of him in pursuit of a doe-antelope and her fawn. The doe was backing away on the plain, keeping the little one, which seemed to understand its part perfectly, close to her hind-legs. Following her closely ran the wolf, often making a dash to the right or left to get at the fawn; but each time the brave little mother, whirling alertly, would present to him her lowered head, and make a dash at his skull with her sharp fore-hoofs. Thus she retired, but I fancy the pursuer's longer breath and varied tactics won the day at last.

The fact that in his hunting he frequently becomes a rival, his incorrigible thieveries, and his unmanly deportment in hanging about like a conscious felon, cause him to be despised by both hunter and ranchman, who take every means to kill him, save by the honorable use of gunpowder. Yet there are times when he makes himself respected and feared.

A prime characteristic of the coyote is his astonishing voice, which differs so much from the well-known wolfish howl of other members of his race as to give him the book-name *Canis latrans*, or "barking" wolf. I can not picture this rattling concert (to which I have often been an unwilling listener) of quickly repeated, infinitely varied, ventriloquial yelps better than it has already been done by Dr. Elliott Coues, who confesses the difficulty of conveying in adequate words the noisy confusion of these polyglot serenades :

"One must have spent an hour or two vainly trying to sleep," says this brilliant writer and naturalist, "before he is in condition to appreciate the full force of the annoyance. It is a singular fact that the howling of two or three wolves gives an impression that a score are engaged, so many, so long-drawn are the notes, and so uninterruptedly are they continued by one individual after another. A short, sharp bark is sounded, followed by several more in quick succession, this time growing faster and the pitch higher till they run together into a long-drawn, lugubrious howl in the highest possible key. The same strain is taken up again and again by different members of the pack, while from a great distance the deep, melancholy baying of the more wary *lobo* breaks in, till the very leaves of the trees seem quivering to the inharmonious sounds."

In the memory of this astonishing voice of his, it is amusing to read the story told by the Kaibabits Indians, of Northern Arizona, to account for the diversity of languages ; for what animal could better figure in such a history than our polyglot wolf ? The old men of the Kaibabits will tell you that in the beginning the grandmother, goddess of all, brought up out of the sea a sack which she gave to the *Cin-aú-av* brothers, great wolf-gods. This sack contained the whole of mankind, and the brothers were bidden to carry it from the shores of the sea to the Kaibab plateau, and by no means to open the package on the way lest, as with Pandora's box, untold evils should be turned loose. But, overcome by curiosity, the younger *Cin-aú-av* untied the sack, when the majority of people swarmed out. The elder *Cin-aú-av* hastened to close it again and carry it to the Kaibab plateau, where the people who had remained found a beautiful home. Those who had escaped were scattered and became Navajos, Moquis, Dakotas, white men, all the outside world in short—poor, sorry fragments of humanity, without the original language of the gods.

The nocturnal prowling, secretive disposition, and remarkable craftiness of this animal, together with the annoyance it has the power to inflict, cause it to figure prominently in the myths and religious histories of the native races of the Far West. Some of these stories I propose to recall, and I am sure they will suggest to every reader at least the reynard of European folk-lore, if not any other interesting parallels.

In all the Mexican pantheon the most sublime figure is that of Tezcatlipoca, creator of heaven and earth, sole ruler of the universe, invisible and omniscient. To him, as presiding over darkness and all mysteries, was dedicated the nocturnal and crafty coyote. Among the central Mexicans the animal was held in so high honor that it had a temple of its own, a congregation of priests devoted to its services, statues carved in stone, and an elaborate tomb at death. Religious significance attached to dogs and wolves in many ways throughout all tropical America, generally through some connection with the moon. On this side of the Mexican line (that is, in the United States) we find the coyote personified in the mythology of the red men as the Creator himself, or as his foremost agent; while here and there it is identified with the sun (which was the visible incarnation of the Creator to the minds of many), or associating with it and representing its demiurgic force.

This was the ancient coyote—the agile-brained and fleet-footed hill-dog of that old mythologic time, and in that wonderful "land of lost gods and godlike men." The wolf of *to-day* is a howling pest, but that wolf's *ancestor*—the first of the line—was divine!

Among the Indians of the Great Basin speaking Shoshonee in any of its many dialects, the belief in animal-gods—a long list of them in varied relations and ranks—as the creators of the world, is at the foundation of religious belief. "By these animal-gods," says Major Powell, "all things were established. The heavenly bodies were created and their ways appointed; and when the powers and phenomena of Nature are personified the personages are beasts, and all human institutions also were established by the ancient animal-gods." In this theism the ancient rattlesnake, *To-go-av*, is the chief of the council, but *Cin-aú-av*, the coyote (or perhaps, there are two brothers of them as happens in so many myths the world over*), comes next in rank, and arranges mundane affairs. In one story the two discuss the matter of food, and decide that it is better that the Uinkareets shall work for a living than that they should be given a self-renewing store of fruits and roots, with honey-dew falling as the snow. In another the elder decided, against the younger brother's wish, that the dead could not return again; whereupon the younger *Cin-aú-av* killed the son of his brother, and long after taunted him with being the first to suffer by this cruel law. "Then the elder knew that the younger had killed his child; . . . and, as his wrath increased, the earth rocked, subterraneous groanings were heard, darkness came on, fierce storms raged, lightnings flashed, thunder reverberated through the heavens, and the younger brother fled in great terror to his father, *Ta-vwots*, for protection."

An almost exact parallel to this story is to be found among the once powerful Nishinam Indians of Central California; but there the two brothers are represented by the coyote and the moon. The moon was good, but the coyote was bad. In making men the moon wished to fashion their souls so that when they died they should return to

* See Brinton's "Hero Myths," and many other authorities in comparative mythology.

earth after two or three days, as he himself does; but the coyote was evil disposed, and declared that when men died the survivors must burn their bodies. The moon was obliged to acquiesce, but before long caused the death of the coyote's son, and insisted upon the application of the law, to the coyote's great disgust. This recalls also a myth of the Bonaks, or Bannacks (of Southern Idaho), who believe themselves to have been developed out of coyotes by the gradual loss of useless members and a slow adaptation to environment. When one of these coyote ancestors died, various animal shapes would spring from the body, many of which took wings and flew away *to the moon.* The old coyotes, fearing the earth might become depopulated, instituted the cremation of corpses.

In the wonderful adventures of the *Sókus Waí-un-ats,* who was first one, then two, in his long contest with Stone Shirt (as told to Major Powell by the Indians who live at the lower end of the Colorado cañons), *Cin-aú-av* appears "extremely proud of his fame as a hunter," but consoles himself by philosophy under the chagrin of a failure. "What matters it," he observes, "who kills the game, when we can all eat it?"—a maxim worthy of a coyote! In that long solar myth told by Utes, how *Ta-vwots,* the little rabbit, went to kill the sun and caused the conflagration of the world, *Cin-aú-av* is the owner of the first field he comes to, and the producer of the ancient corn whose seed descended to plant the fields of to-day; and he is the hero of many another religious story told by Shoshonee and Kalispel firesides. Nor is this true of Flathead, Ute, and Shoshonees alone. The native races of Northern California were superior in all respects to those living in the southern part of the State; and among them legendary lore reached a degree of perfection not common with Western Indians. In most of these fables the coyote plays a conspicuous part, for the forces of Nature, in whose phenomena most of these stories find their natural origin, are portrayed there (as among the Shoshonees) by animal personages. These ancient animal-gods, represented by degenerate descendants, have also duplicate spirits that visit the world, and whose influence can be secured. Thus, when one Karok has killed another, he frequently barks like a coyote, in the belief that thereby he will be endued with so much of that animal's cunning as will enable him to elude punishment. Perhaps the custom of the medicine-women of this nation of squatting beside an ill man and barking at him for hours together, indicates a similar prayer for sagacity in diagnosis.

The deity and creator of the Karok religion was Kareya, who made the fishes, the mammals, and finally The Man. Him he commanded to assemble all the animals, in order to assign to each its rank, by distributing bows and arrows, the longest to the most powerful, and so on down the scale. The beasts and birds came together the night before the distribution, and all went to sleep except the coyote, who determined to stay awake all night and go forth earliest in the morning to get the longest bow. He took extraordinary pains to keep awake, but overreached himself in an excess of ingenuity, and fell asleep just before dawn. When he opened his eyes only the very shortest bow was left for him. But Kareya, pitying his weakness and disappointment, gave him cunning ten times greater than before, so that he was sharp-witted above all the animals in the wood. In return, the grateful coyote befriended The Man and his children ever afterward, doing many helpful things for them. Similarly among the Nishinam, where his history began as the evil principle, assisting at the creation, the coyote afterward turned friendly, killing two cannibal giants, procuring fire for the tribe, and doing other feats common to solar heroes the world over. He obtained fire on the plan of the monkey and the cat in the matter of roasted chestnuts—by sending after it the lizard, who, with the bat and sand-hill crane that helped him, saw some exciting adventures.

When Kareya made the fishes he did not let the salmon come up the Klamath, in consequence of which the Karok, who live on its upper part, were sorely pressed for food. But Kareya had made a great fish-dam at the mouth of the river, and given the key to two old hags to keep, who never ceased the watching even to sleep. Seeing that the Indians were nearly starved, the coyote befriended them. He made a visit to the hags on an ingenious pretext, but only succeeded so far as to find that the key was kept too high for him to reach it. He stayed all night in the cabin with the hags, pretending to sleep, but watching their movements out of a corner of his eye. In the morning one of the hags took down the key and started to get some salmon for her breakfast. Then the coyote happened to think of a way to get the key. Jumping up he darted under the hag, throwing her down and causing her to fling the key a long way off. Before she could scramble up, the coyote had seized the key and opened the dam. Thus the salmon could ascend the Klamath, and the Karok had plenty of food. But they had no fire to cook it with, because Kareya had hidden it in a casket which he gave to two sleepless hags far toward the rising sun. So the coyote promised to try to get this second boon for them.

He stationed a line of animals all along the road from the home of the Karok to the far-distant land where the fire was, the strongest near the fire, and last of all concealed an Indian under a hill. This done, the coyote insinuated himself politely into the good graces of the old guardians, and lay by their hearth all night feeling very comfortable and pretending to sleep. But he was soon convinced that without help there was no way to elude their vigilance; so in the morning he stole out and had a talk with the Indian under the hill, after which he went back and lay down by the hearth as before. Presently, as had been concerted, the Indian was heard hammering at the door, as if to break it in, and the old beldames rushed out to drive him away. This was the coyote's opportunity. As the hags dashed out at one door, the cunning thief seized a flaming brand in his teeth and leaped through the other. He almost flew over the ground, but the hags saw the sparks and gave chase, gaining on him fast. By the time he was out of breath he reached the puma, who took the brand and ran with it to the next animal, and so on. Last of all was the frog, who caught the fire in his mouth, swallowed it, and dived, the hags catching his tail (he was a tadpole then) and twitching it off in the act. The frog swam under water a long distance, then came up and spat the fire into a log of drift-wood, and there it has stayed ever since, so that when an Indian rubs two pieces of wood together the fire comes forth. Another cognate myth (Gallinomero) says dry wood was first invested with this perpetual spark after the coyote had rubbed two pieces together until they ignited. The Navajos recount a similar fable. They, too, lacked fire, and were in distress, so the coyote, the bat, and the squirrel promised to get it for them, the fire seeming to be in the possession of the animals in general at a distance. The coyote fastened pine splinters in his tail, went to the place where the article was to be had, dashed through the flames and started homeward at full gallop. When out of breath the bat relieved him and flew till he was ready to drop, when the squirrel caught the torch and carried it into the camp of the Navajos. This recalls the Nishinam fable, though the two tribes belong to different linguistic stocks, and live a thousand miles apart. The Shastikas account for the origin of fire by saying that a long time ago there was a fire-stone in the East, white and glistening like pure crystal, which the coyote brought and gave to the Indians.

After Kareya had made him so amusing, the coyote grew ambitious and tried many feats which Kareya had never intended for him. The Karoks explain meteors, and especially those that seem to burst, by a story of these failures on the part of the adventurous animal who waited on a mountain-top and tried to dance with the stars. The star took him up, but would not stop when the novice grew tired, because Kareya had made it to keep moving. Thus he was compelled to go on dancing and dangling until he fell to pieces. Among the Navajos one hears that after the sun and moon had been made in the heavenly workshop, the "old men" set about embroidering the sky with stars in beautiful patterns; but, just as they had made a beginning, the coyote rushed in and contemptuously scattered the pile of stars broadcast over the floor of heaven, just as they now lie. The Kern River (California) tribes (related to the Pi-Utes) recite a complicated myth of how the coyote once made a trip through the sky in company with the sun. Another Californian race, the Tatus, believe the coyote to have been the original of human kind, and one of their legends accounts for Clear Lake, near which they dwelt. Many hundred snows ago, while men were yet in the form of coyotes, an exceedingly great drought parched the land, during which a famous coyote and his two sons ate many grasshoppers—all the animal life there was left. The only water was in Clear Lake, and thither they journeyed. The sons died on the way, but the father reached the lake and drank it dry. Then he lay down and fell asleep. As he slept, there came a man from the south and pricked him with a spear, so that the waters flowed forth from him and returned to the lake until it was full again, while the grasshoppers he had eaten became fishes. There are other legends accounting for this deep and beautiful piece of water in which the coyote is made to exercise supreme functions.

In the early days of the earth, as a Gallinomero philosopher will teach you, all Nature was wrapped in darkness, and there was dire confusion and endless collisions, one of which brought the coyote and hawk together. Instead of indulging idle recriminations, they consulted how they could improve this state of things. The coyote groped his way into a swamp and gathered a quantity of dry *tules* which he rolled into a large ball. This he gave to the hawk, with some flints, and sent him up into heaven with it, where he touched it off and sent it whirling round the earth. This was the sun. The moon they made in the same way, only the *tules* happened to be damp and did not burn so well. There is a legend current among the Papagos on the Gila River, Arizona, of a deluge from which only their great myth-hero Montezuma (not to be confounded with the veritable Aztec emperor whom Cortes saw) and the coyote escaped. The coyote had foretold this deluge, and Montezuma had hollowed out a canoe, while the coyote prepared for himself an ark in a hollow cane.

The Ashochimi preserve a legend of a flood which drowned all living creatures except the coyote. Seeking out over all the world the sites of the antediluvian villages, he gathered the floating tail-feathers of hawks, owls, and buzzards, and planted one wherever a wigwam had stood. In due time these feathers sprouted, branched, and finally turned into men and women.

The Pitt-River (California) Indians have a somewhat similar story. Their coyote began the earth by scratching it up out of nothingness. Then the eagle complained that he had no perch, whereupon the coyote scratched up great ridges. When the eagle flew over them his feathers dropped down, took root, and became trees, and the pin-feathers bushes and plants. After men had been created, they were freezing for want of fire, stole some of it, and kindled a fire in the mountains, to which the Indians resorted. The Shastika say that originally the sun had nine brothers flaming hot with fire, so that the world was likely to perish, but the coyote slew them, and saved mankind from burning up. There were ten moons also, all made of ice, so that in the night people nearly froze to death. Nine of these the coyote slew with his flint knife, carrying heated stones to keep his hands warm.

The Miwok possess a very elaborate myth of the creation of man, in regard to which the coyote called a council of animals after he had finished fashioning the globe and all the inferior creatures. Each speaker wanted to form man just like himself. The coyote made free to say that this was all nonsense; he did not think himself the most perfect animal that could be made, and he announced it as his theory that man should be formed by taking the best points of all the others—strong voice, like a lion; lack of tail, like a bear (since, in his opinion, a tail was only a harbor for fleas); the sharp eye of the elk, and so on. "But," said the autocrat, "there surely is no animal from whom man can borrow *wit* besides myself, and therefore he shall resemble the coyote in being cunning and crafty." Then the council broke up in a row, and there was a general battle, following which every animal set to work to make an earthen image after his own ideas. Night came before any models were finished, and all the sculptors went to sleep except the coyote, who, when the camp became still, destroyed the other models, made the composite one he had proposed, and gave it life at the coming of the dawn.

The quick wits and inquiring mind of the prairie-wolf serve him not only in chasing but in saving himself from being chased. Next to the wolverine he is perhaps the wariest of animals—not excepting the fox—against which the trapper pits himself. To poisoned meat he falls a victim through his exorbitant appetite, and in this way the ranchmen destroy great numbers annually; but he is rarely trapped. Say tells, with a touch of glee, how Titian Peale was baffled in trying to catch a coyote for his famous museum—one of the sights of old Philadelphia.

Peale's first experiment was with a "figure 4," which came to naught because a wolf burrowed under the floor and pulled the bait down between the planks. "This procedure," remarks Mr. Say, "would seem to be the result of a faculty beyond mere instinct." A cage was constructed, into which the wolves might enter, but out of which they could not again escape. The coyotes came, admired this arrangement, sang doleful jeremiads over the bait which they could see and smell, but could not taste, and went away again, wondering at the heart of mankind and the malignant devices thereof.

Disappointed here, Mr. Peale next began a series of experiments with steel traps, one of which, profusely baited, was concealed among the leaves. Plenty of tracks—"you can't live on tracks!" is one of the aphorisms of the plains—alone rewarded this effort. Then a seductive bait was suspended above the trap in the midst of several other pieces, but the expected victims, stepping circumspectly, carried off all the meat except the one piece it was intended they should take. Baits were next hung up as before, the trap was buried in leaves, and these were burned, so that the trap, scorched free from any odor of human handling, lay covered with ashes; still, the one bait over the steel jaws was avoided, and no sinewy foot was pinched. Finally, a wicked arrangement of innocent-looking logs set on a trigger was made to fall upon the poor wolf and destroy him. Peale got his "specimen," but it was only by brute force; the coyote was a match for him in brain.

The skins of these wolves are not so highly valued as those of the big gray wolf, yet formerly they entered largely into the shipments of the Hudson Bay Company, for whom they were "cased" or stripped off wrong side out, as is done with the smaller animals. At present they are in demand to a small extent for making sleigh-robes, rugs, etc., but can scarcely be counted among the commercial furs.

The striking resemblance between the coyote and the majority of the snappish curs thronging in the camps of the redskins long ago attracted attention, and with good reason, for they are descended from tamed wolves of one kind or another, and the stock is constantly and designedly replenished by their masters through mixture with the wild wolves.

As a pet, the coyote is not in great favor. He will, indeed, stay at home and consent to friendly and even affectionate terms with his owner, but he seems to have not a particle of gratitude, nor any of that responsive attachment which makes the well-bred dog so lovable as a friend. Moreover, in spite of his natural subtlety and shrewdness, he shows little aptitude for learning the ordinary accomplishments of dogs, and so fails to sustain an interest in himself after the novelty of first acquaintance has worn off. He is faithful to his model, and lives up to the motto, "Once a coyote always a coyote."

THE EXPERIMENTAL STUDY OF NATURE.*

By Dr. F. W. PAVY, F. R. S.

THE next part of my duty is to exhort the fellows and members of this college "to search and study out the secrets of Nature by way of experiment." These are the directions I am to follow, and they give me a wide field to select a course of procedure from. The kind of exhortation I shall employ will consist in placing before you a view of the method of work which Harvey himself adopted, and then, as an incentive to follow his example, I will display some of the fruit yielded by recent research conducted upon the lines of his procedure.

The object to be promoted is the acquirement of additional knowledge. It is an old but true saying that knowledge is power. We accept the doctrine, which comes to us in definite shape from no less

* From the "Harveian Oration," delivered at the Royal College of Physicians, London, October 18, 1886.

ancient an authority than Aristotle, that there is no such thing as innate knowledge—that knowledge of every kind has to be acquired, and that it is based upon perceptions reaching the mind through the senses. Harvey thus epitomizes what was said by Aristotle respecting the manner in which the knowledge appertaining to science is acquired: "The thing perceived by sense remains; from the permanence of the thing perceived results memory; from multiplied memory, experience; and from experience, universal reason, definitions, and maxims or common axioms." In its elementary form, knowledge consists of simple inferences drawn in a direct manner from impressions. A child once burned afterward shuns the fire. From the impression received an inference is framed which forms the foundation for future action. The same kind of operation determines the conduct of the lower animals. By mental action these simple inferences may be raised into or give rise to knowledge of a higher kind. This is what for science is required to be done. The exercise of the intellectual faculties must be brought into operation, in order that what we acquire through perception may be shaped into the knowledge that it is desired to obtain. The object in science is to discover the facts and laws of Nature; and, to apply the intellect advantageously for the purpose, there must be some systematic course, some method or art of reasoning, adopted. The system employed up to Harvey's time was the Aristotelian, or syllogistic—a system which, while being well adapted for affording proof upon any particular point, is ill adapted for promoting the advance of knowledge. When through the major and minor premises of a syllogism I draw a conclusion, a point is proved, but no real addition is made to our stock of knowledge. For instance, when in accordance with the rules of the syllogistic art I say—"All men are mortal: Thomas is a man, therefore Thomas is mortal"—I start with the general proposition in the major premise that "all men are mortal," and arrive at the conclusion, through the minor premise, that a particular individual is mortal. A certain attribute—mortality—is asserted to be possessed by a class. A member of the class must also possess the attribute, and this is all the information that my syllogistic conclusion has given me—that the individual named Thomas possesses the attribute of mortality, which belongs as a general character to the group of individuals of which he is a member. The two premises of the syllogism already consist of established truths, and for a syllogism to be valid there must be nothing contained in the conclusion beyond what is asserted in the premises. The train of reasoning, therefore, is not adapted to lead us to the acquirement of new knowledge. The essence, indeed, of the system consists in proceeding from generals to particulars. The major premise with which we start is, in reality, a general proposition, containing knowledge which has been acquired—not, it is true, by the methodical application of induction, but nevertheless after the manner of induction—by observation repeated and confirmed until the thing has come to be accepted as an established truth.

Harvey was shrewd enough to perceive that such a system of reasoning, which had continued in use up to the period in which he lived, did not assist in the disclosure of the secrets of Nature. He says: "The method of investigating truth commonly pursued at this time is to be held as erroneous and almost foolish, in which so many inquire what others have *said*, and omit to ask whether the things themselves be actually so or not; and single universal conclusions being deduced from several premises, and analogies being thence shaped out, we have frequently mere verisimilitudes handed down to us instead of positive truths." Men's minds must have evidently now become occupied with the new system of philosophy set forth by Lord Bacon, in his "Novum Organum," or "True Directions Concerning the Interpretation of Nature." One of the aphorisms of this work clearly exhibits the difference between the new system and the old: "There are and can be only two ways of searching into and discovering truth. The one flies from the senses and particulars to the most general axioms, and from these principles, the truth of which it takes for settled and immovable, proceeds to judgment and to the discovery of middle axioms. The other derives axioms from the senses and particulars, rising by a gradual and unbroken ascent, so that it arrives at the most general axioms last of all." Upon system, or plan of procedure, a great deal depends: look at any undertaking carried out under a good system and a bad. The ancients were a long time in learning the right system to adopt, but it was indeed a great day for science when the method of reasoning by induction was introduced. Starting with particulars or facts which are collected from Nature by observation and experiment applied in every available way, it proceeds step by step in the process of generalizing until the largest and widest propositions are obtained. From the proposition which has been formulated out of, it may be, only a few facts, advance is made with the aid of other facts to propositions of a more and more general character. The unknown is brought into the domain of the known, and as this domain increases, not only is the position acquired strengthened, but at the same time rendered more advantageous for the attainment of further extension. Thus the march onward proceeds, and when some general law of Nature—like, for instance, gravitation, the correlation of the physical forces, or, even, with a more limited bearing, reflex spinal action—is discovered, a gain is made which, through reflected influence, has the effect of at once immensely enlarging and perfecting the understanding. Truly, it may be said, the explorer by the inductive method does not know whither he may be led. He dedicates himself

"To unpathed waters—undreamed shores,"

and follows simply the direction indicated to be taken by what happens to be revealed. Guided entirely by the facts disclosed by observation and experiment, he brings the instrumental agency of the mind as a reasoning power to bear upon them, and draws from them that which adds to the store of knowledge already possessed. He seeks for facts and interprets their meaning as they come before him. This was the course pursued by Harvey. Instead of giving himself up, as others had done before him, to arguing out conclusions from accepted axioms, he struck out into the hitherto untrodden path of inquiry—that of induction—and sought knowledge by a direct appeal to Nature through the medium of observation and experiment. "It were disgraceful," he says, "with this most spacious and admirable realm of Nature before us, did we take the reports of others upon trust, and go on coining crude problems out of these, and on them hanging knotty and captious and petty disputations. Nature is herself to be addressed; the paths she shows us are to be boldly trodden."

In the discovery of the circulation, Harvey applied the principles of induction, and argued upon them in a strictly logical way. He showed himself to be a good and careful observer, judged even by the standard set forth in the following words of John Stuart Mill, on the process of observing. "The observer," says Mill, "is not he who merely sees the thing which is before his eyes, but he who sees what parts that thing is composed of. To do this well is a rare talent. One person, from inattention, or attending only in the wrong place, overlooks half of what he sees. Another sets down much more than he sees, confounding it with what he imagines or with what he infers. Another takes note of the *kind* of all the circumstances, but, being inexpert in estimating their degree, leaves the quantity of each vague and uncertain. Another sees, indeed, the whole, but makes such an awkward division of it into parts, throwing things into one mass which require to be separated, and separating others which might more conveniently be considered as one, that the result is much the same, sometimes even worse, than if no analysis had been attempted at all, It would be possible to point out what qualities of mind and modes of mental culture fit a person for being a good observer; that, however, is a question not of logic, but of the theory of education, in the most enlarged sense of the term."

The experiments which Harvey conducted on the arteries and veins to assist him in his inquiry were founded upon a well-devised plan. It may be said of experiment, that it affords the means of varying the circumstances, and thus aids immensely the acquirement of knowledge by induction. In the application of the faculties to discovery, the mind asks itself what facts are needed to assist in the establishment of a correct conclusion. The fact may be looked for among the varied instances presented by Nature; or, by an artificial arrangement of circumstances, the required instance may be made—in other words, experiment may be had recourse to for supplying what is wanted. In the one case, we get our fact by observation from the variations in the circumstances spontaneously furnished by Nature; in the other, we obtain it from experiment, which possesses the great advantage over observation not only of furnishing us with a much greater number of variations than is to be found naturally presented, but also of enabling us to produce the precise form of combination or variation which is needed for our purpose.

Harvey, in a true sense, adopted the Baconian system of interrogating Nature by appeal to observation and experiment, and drawing conclusions out of the facts presented, and yet it is evident that the "Novum Organum" was not published till after the discovery of the circulation was made. Bacon's new method of conducting research and discovering the truths of Nature was placed before the public in 1620. Harvey's work on the circulation, "Exercitatio Anatomica de Motu Cordis et Sanguinis Animalibus," was not published till 1628, but it has been generally allowed that his discovery was made known in his first course of Lumleian lectures, delivered at the college in 1616; and, thanks to the meritorious labors of a committee of the college, this has now been rendered open to verification by the very interesting volume just prepared, and on the point of being issued, containing a reproduction in autotype form of his original lecture-notes in his own handwriting. Harvey, then, must have been thoroughly in the van of progress taking place in his day; and, further, the contemporaries of Bacon must have been acquainted with the new system of philosophy before the "Novum Organum" was published.

Harvey's discovery established a new departure in physiology. Without a knowledge of the circulation, nothing really could be known about the various operations taking place within us. It is hard, with the knowledge now possessed, to realize the state existing at the time the circulation was discovered. The passage of blood from the right to the left side of the heart had, it is true, already been recognized, but it was taught that the blood went to the lungs for their nutrition, and "to be elaborated and subtilized by the reception of a spirit from the air in inspiration, and the exhalation of a fuliginous matter in expiration." The heart and arteries were supposed to be the seat of the vital spirit, and the liver to be the fountain whence the body was supplied with blood through the veins, in which there was believed to be a to-and-fro current, a flux and reflux, that was compared to the ebb and flow of the tide in the classic straits of Euripus. Truly, indeed, may it be asserted, that our ancestors stand in the twofold position of our parents with respect to age, our children with respect to knowledge.

It was not without opposition that Harvey's views were received; and the high position in his profession he had attained did not suffice to prevent his escape from the effect of the prejudice against innovation entertained by the multitude. Aubrey tells us he had "heard him say that after his book on the circulation of the blood came out, he fell mightily in his practice; 'twas believed by the vulgar that he was crack-brained, and all the physicians were against him." Harvey lived, however, to see his doctrine generally accepted. But such are the vicissitudes of time, that in our day an attempt has been made to deprive him of the title of discoverer of the circulation, and give it to an Italian physician, Cesalpino, because it has been found that a few words of what he wrote can be construed into suggesting that a conception of the circulation existed in his mind. Most ably and successfully have my predecessors in the delivery of this oration, Sir Edward Sieveking and Dr. George Johnson, combated the claim that has been put forward on behalf of Cesalpino, and maintained the position of Harvey.

Science prepares the ground for the exercise of art. The one—science—is concerned with knowledge as knowledge; the other, with the application of it to a practical end. Our art—our *raison d'être* as members of the medical profession—is to apply the knowledge of medical science to the prevention of, cure or mitigation of, and alleviation of the sufferings from disease—to secure, in fact, for man as natural a passage through life as happens to be attainable. We can not prevent death. Lord Bacon, in his essay "De Morte," said:

"Æque enim est naturale hominibus mori, ac nasci."

True, it is as natural to die as to be born; and Nature's laws must be complied with. Our aim is to avert premature death. A certain power, given to us at starting upon our existence, carries us on, under exposure to the proper conditions or influences for keeping this power going. But, in the exercise of its action, although for a while it shows no signs of a failing tendency, yet assuredly it progresses toward exhaustion and ultimate extinction. Accompanying, and doubtless dependent on, the declining power, and assisting in leading to its becoming extinguished, there is an advancing deterioration of the material organism in which the power is manifested. Such is what is natural; but many circumstances contribute to avert the natural, the ordinary course being run. The power given to start with may not be equal to the standard, and the issue of generation may, in consequence, present itself under a weak and ill-developed form, easily falling a victim to influences that there ought to be strength enough to resist. There may be a taint in the power derived by generation from the parents—something transmitted by inheritance, which may give rise to a tendency to the development of some structural deviation from the natural state, or to the performance of one or other functional operation of life, in a manner that does not conform with what may be said to be strictly natural. It is a law of Nature for the offspring, more or less closely, to assume the likeness of the parent, and likeness in the shape of what is wrong may be assumed as well as in the shape of what is right.

Quitting the quality of the power given to us to start with, we are next dependent upon the influences derived from the external or surrounding conditions to which we become exposed. Light, air, what we eat and drink, or what in any way gets into the system, temperature, exercise of mind and body—in short, the conditions under which we live—all exert their influence in favoring or otherwise a natural passage through life. Within us, operations forming a part of the operations of Nature proceed, but these operations are influenced by—owe their activity, indeed, to—the surrounding conditions, and thus it is that upon these surrounding conditions depends whether a natural course is run or not. Under the same law, these surrounding conditions may exert a modifying influence in this or that particular direction upon the operations that are proceeding, and by long continuance in force may lead to the establishment of a more or less modified state as a part of our nature, in accordance with the Darwinian principle of natural selection. This matter—the modifications for good or bad, wrought in our nature by the influence of external conditions—embraces a wide field of study, and comprehends nothing less than the possession of a knowledge of the varied operations, with the laws determining them, going on around us, in order that we may understand the manner in which they are brought about. It is a vast subject, but the mind of man has already done much, and there is reason to think will do much more, toward penetrating it; and, as with the amount of knowledge acquired, power is possessed—that is, the power of arranging conditions or operations so as to render them subservient to the production of a desired effect—man stands in the position of an increasingly powerful agent in the realm of Nature. Must not the mind itself, then, through which this is accomplished, be reckoned as a power—a great power among the powers of the universe? In our special department as medical practitioners, it falls to us to apply the power which knowledge gives us toward preventing unnatural conditions of the body from being allowed to become developed, and toward bringing the unnatural back into the natural state—in fact, toward aiding in carrying life on in a natural manner through its ordinary term of existence.—*Lancet.*

VINEGAR AND ITS MOTHER.

By FREDERIK A. FERNALD.

"SWEET as sugar" and "sour as vinegar" are among the most common comparisons in our language, and the two substances chosen to represent these opposite qualities are popularly deemed as unlike as they can well be. Yet it is one of the marvels of chemistry that the sourest substance with which we are familiar is made from the sweetest. By the action of a ferment, the sugar in some sweet liquid is turned first to alcohol, and the alcohol then changes to acetic acid, which is the acid in vinegar.

In Great Britain, vinegar, until recently, has been manufactured almost entirely from malt—a wort, or sugary solution, weaker than is employed for beer, being first made. Of late years, glucose, cane-sugar, and molasses, have been largely used. British "proof-vinegar" contains 4·6 per cent of anhydrous acid. A notion formerly prevailed that sulphuric acid acted as a preservative to vinegar, and one tenth of one per cent was allowed to be added. Makers continued the practice after they knew that it had no such effect, as it increased the apparent strength of their vinegar at a slight cost. This addition is now an illegal adulteration.

In France, and elsewhere in Europe, the manufacturer starts with an alcoholic liquid, already partly acetified—light wines that have turned sour being generally employed. The French name, *vinaigre*, from which the English word vinegar is derived, means *sour wine.* Two sorts are produced—white-wine and red-wine vinegar—the former being generally preferred. These are fine-flavored and somewhat stronger than the malt-vinegar of Great Britain. Six and one half to seven per cent of acid have been found in French vinegars. Sour ale and beer do not yield good vinegar.

In the United States, cider vinegar has long held the preference, and, if the cider has been made from sound, sweet apples, the vinegar has a very agreeable flavor and color. The old-fashioned way which is followed by farmers in making vinegar is to set out-of-doors in the spring a barrel of cider which has become too "hard" and sour to drink, from the sugar partly turning to alcohol and acetic acid. The bung is taken out of the barrel, and the bung-hole is loosely stopped by sticking the neck of a large bottle into it. Such exposure to the air at a warm temperature effects the conversion of the cider to vinegar in three or four months. The change goes on very slowly, because the air can act only on the surface of the liquid, and fresh portions of alcohol are brought to the surface only as the newly formed acid sinks and mingles with the liquid below. The best cider-vinegar is made from new cider, and it is well to cause several fermentations to take place by adding a fresh quantity of cider every two weeks.

Vinegar is chemically a dilute solution of acetic acid, containing minute quantities of fragrant ethers, which give it its odor, and some brownish substance, to which is due its color. Other matters, derived from the liquid from which the vinegar is made, are sometimes accidentally present, as sugar, gum, starch, cream of tartar, and other salts, etc. It usually consists of between ninety-three and ninety-seven per cent of water, the rest being acid, except a fraction of a per cent of solids. The transformation of the sugar in fruit juices or sirups to acetic acid takes place according to the following chemical reactions :

$$\underset{\text{Sugar.}}{C_6H_{12}O_6} = \underset{\text{Alcohol.}}{2C_2H_6O} + \underset{\text{Carbonic dioxide.}}{2CO_2}$$

The bubbles which appear when cider is "working" are carbonic dioxide. In the conversion of alcohol to acetic acid, a subtance called aldehyde is first formed. The oxygen for these changes is taken from the air:

$$\underset{\text{Alcohol.}}{C_2H_6O} + \underset{\text{Oxygen.}}{O} = \underset{\text{Aldehyde.}}{C_2H_4O} + \underset{\text{Water.}}{H_2O}.$$

$$C_2H_4O + O = \underset{\text{Acetic acid.}}{C_2H_4O_2}$$

By substantially the same slow process as that still employed in the household was all vinegar obtained from the time of Moses, or earlier, down to 1822. In 1814 Berzelius had found out the chemical composition of acetic acid, and De Saussure that of alcohol; so that, after Doebereiner had discovered that a weak solution of alcohol exposed to the air in contact with platinum-black was converted to acetic acid, he was enabled to set forth the theory on which depends the modern "quick process" of vinegar-making—the method now regularly employed in the vinegar-factories of Europe and America. The essential feature of this process consists in bringing the alcoholic solution into intimate contact with the air by causing it to trickle through a mass of loose material, which effects the acetification in from twenty-four to forty-eight hours. The operation is carried on in wooden tubs, six to ten or more feet high, called generators. Around the sides of the generator, a few inches above the bottom, is a ring of air-holes. Just above the air-holes is a perforated false bottom, and from this nearly to the top the generator is filled with beech-wood shavings, which are closely curled so that they will not crush and prevent the air circulating freely through them. A few inches above the shavings is a wooden head or sieve, perforated with small holes, which serves to distribute the alcoholic liquid, or "wash," evenly over the shavings. Several air-pipes are inserted in the sieve, extending a few inches above and below it. The generator has a cover with a hole in the middle through which the wash is poured in, and the ascending current of air passes out. The vinegar-room is kept at a temperature between 70° and 90° Fahr. A high temperature and large supply of air hasten the operation, but cause loss by the evaporation of the alcohol. If the temperature falls much below 60°, the acetification stops, and putrefaction sets in; while if too little fresh air is supplied, aldehyde, the half-way product mentioned above, instead of being promptly converted to acetic acid, is evaporated and lost. The presence of aldehyde in the air may be detected by its penetrating aroma and by the eyes smarting. The wash must be passed several times through the shavings, in order to effect its complete acetification.

Two kinds of vinegar are sold by grocers in the United States for domestic use—cider-vinegar and white-wine vinegar. Both kinds are made in factories by the process just described. Massachusetts, New York, and some other Eastern States have laws concerning vinegar. In these States the cider-vinegar may be depended on as being really made from cider, for the risk of heavy penalties is incurred by offering anything else under this name. The laws require, also, that all vinegar shall contain four and a half per cent of acetic acid. Cider-vinegar contains a little malic acid, and will give a precipitate with acetate of lead. The absence of the precipitate shows that the sample is not cider-vinegar; but other vinegar, to which malic acid has been added, will, of course, yield the precipitate. Many persons still retain a strong preference for cider-vinegar, but this, like the old preference for feather-beds, is gradually passing away. As rotten apples, and more or less of other kinds of dirt, commonly go into the cider-mill with the sound fruit, and no thorough purification of the product is attempted, not much can be said for home-made cider-vinegar on the score of purity. Many times as much white-wine as cider vinegar is now consumed in the United States. The white-wine vinegar, however, is not made from white wine, as that beverage is not sufficiently abundant in this country to supply the demand of the vinegar-manufacture. Until recently, manufacturers started with whisky, rum, or other alcoholic liquor, but they are now allowed to produce their own spirits. In the East, molasses, and in the West a wort from grain, is first fermented in a vinegar-still—an apparatus having no worm—and a liquor containing fifteen to twenty per cent of alcohol is produced. The liquor is then converted to vinegar in the usual way. This vinegar is perfectly colorless, and the brownish color which the consumer expects in vinegar is given to it by the addition of some harmless substance, as burned sugar, or an infusion of roasted barley-malt. Cider-vinegar has an agreeable flavor, due to the presence of acetic ether and malic acid. Vinegar from well-flavored wines is the most agreeable, as the ethers which give the bouquet to the wine produce a pleasant flavor in the resulting vinegar. Whisky containing fusel-oil yields a pleasant vinegar, as the fusel-oil during the acetification is decomposed into fragrant ethers. Vinegar is flavored artificially by adding to the last wash oil of cloves, or some fragrant ether.

A recipe is given in Ure's "Dictionary," by which it is said that an excellent vinegar for domestic use can be made. To each gallon of a sirup, containing one and a quarter pound of sugar to a gallon of water, is added one quarter of a pint of good yeast. The liquid is kept at a temperature of from 75° to 80° Fahr. for two or three days, and is then racked off from the sediment into the ripening-cask, where one ounce of cream of tartar and one ounce of crushed raisins for each gallon is mixed in. When the vinegar is freed from any sweet taste, it is drawn off clear into bottles and closely corked.

Vinegar should not be kept in metallic vessels except those of silver or perfectly clean copper. Earthenware glazed with oxide of lead (litharge) should never be used, but salt-glazed ware is safe. Vinegar is rarely adulterated with sulphuric acid; and oxalic acid, which is a violent poison, has also been found in it. According to the "United States Dispensatory," if vinegar is evaporated in contact with white sugar, or on white paper, the presence of free sulphuric acid will be indicated by charring. Such acrid substances as red pepper and mustard are sometimes added to vinegar to increase its apparent sharpness. They may be detected by their biting taste after evaporating a portion of the vinegar to a small bulk. Consumers need have little fear of adulterations, however, if their vinegar comes from ordinarily reputable dealers; besides, genuine vinegar can be made more cheaply than any passable imitation. There is more chance of unwholesome vinegar coming into the household in pickles and catchups than when the vinegar is bought alone.

By distillation vinegar is deprived of its coloring and other non-volatile matters. The product is always weaker than the vinegar from which it is derived, as the boiling-point of strong acetic acid is above that of water, and it contains small quantities of alcohol and empyreumatic bodies formed during the operation. Distilled vinegar was formerly used in pharmacy, but dilute acetic acid has now taken its place.

The acetic acid used in the arts is not obtained from the acetification of alcoholic liquors, but from the destructive distillation of wood, generally in the form of sawdust. It is called commercially pyroligne, ous acid, or wood-vinegar, and contains as impurities tar, wood-spirit-etc., which give it an empyreumatic or smoky odor, and which make it superior to other vinegar for preserving meats, pickles, etc. It is purified, and with the addition of coloring and flavoring matters has been sold for culinary use. As the complete purification is an expensive process, there is danger that this vinegar, if sold at a low price, will contain unwholesome substances.

The value of vinegar as a condiment depends on the fact that acetic acid dissolves gelatin, fibrin, and albumen; hence it aids in digesting young meats, fish, lobsters, and hard-boiled eggs. The acid assists also in the conversion of cellulose into sugar, which is the first stage in the digestion of the green leaves used in salads. It is a mistake to use vinegar on beans, for it renders insoluble the legumin, which is their chief nutritive constituent. Oil, pepper, mustard, and a little white wine make the best dressing for beans. It has been proved that some vegetable acid is necessary for the preservation of health, as long continuance in a diet lacking such acids produces scurvy. Vinegar will partly supply this lack, but not wholly, for it will not prevent or cure scurvy. A craving for acid is better satisfied by fruit or acid vegetables. Those young girls who indulge largely in such indigestible articles as pickled limes, cucumbers, etc., would enjoy better health if they should eat instead sour apples, tomatoes, and rhubarb- and cranberry-sauce. The habitual use of vinegar in considerable quantities leads to dyspepsia; the form becomes wasted, on account of insufficient nutrition; and death has been known to result.

Vinegar is used in medicine for its astringent action, being employed locally to check hæmorrhage. It is also a refrigerant, for sponging the skin with diluted vinegar has a cooling effect. The heat and pain of sprains and bruises are relieved by applying to the place brown paper soaked in diluted vinegar. This use of vinegar is celebrated in the lines of a certain well-remembered lyric:

"And Jill had the job
To plaster his nob
With vinegar and brown paper."

Aromatic vinegar, called also "Vinegar of the Four Thieves," Marseilles vinegar, or camphorated acetic acid, is strong acetic acid, in which are dissolved certain essential oils, and sometimes camphor. It is said to have been used by a band of four thieves, during a plague at Marseilles, to protect them from infection while plundering the houses and bodies of the dead. It is now used only in smelling-bottles, or *vinaigrettes*, for cases of fainting, a bit of sponge or some crystals of sulphate of potassium being put into the bottle and moistened with the liquid. Aromatic vinegar is very fragrant and volatile, and must be kept in closely stoppered bottles. A variety of recipes for it are given: that especially recommended in the "United States Dispensatory" is one and a half fluid drachm best oil of rose-geranium, fifteen minims oil of cloves, and four fluid ounces glacial acetic acid.

The tough, leathery substance, commonly called "mother," which forms in vinegar, is one of the many fungi whose spores float in the air, settle as dust on exposed objects, and fall into exposed liquids, ready to grow into a bulky plant when conditions favor. The exact position of the vinegar-plant among the fungi has not been settled. Turpin, Berkeley, and others, say that it is the abnormally developed mycelium, or vegetative part, of *Penicillium glaucum*, of which common mold is the reproductive part. Pasteur and others maintain that it is a distinct species, calling it by the name *Mycoderma aceti*, and state that common mold frequently grows on its surface. Under the microscope it has been found to exhibit two forms — the minute, rounded particles called micrococci, and the rod-like forms known as bacilli. The vinegar-plant develops during the process of acetification, and its presence tends to accelerate the operation. Manufacturers get rid of it as soon as possible, for it interferes with the flow of the vinegar through their apparatus. It grows on the surface of the vinegar, and if not disturbed will cover the whole surface, conforming to the shape of the vessel. It has been known to reach a thickness of half an inch. The mycoderm seems to have an oxidizing action, and so, when the alcohol in the liquid fails, it probably grows at the expense of the acetic acid, converting it to carbonic dioxide and water. There is a popular notion that the presence of "mother" shows that the vinegar is made from cider, and is of good quality, but the vinegar-plant appears also in vinegar made from molasses, and it is really as undesirable in vinegar as mold on bread.

The little, wriggling creatures which swarm in some vinegars have been credited by uneducated persons with being the "life" of the vinegar. In one sense they are, but their presence is in no way beneficial. These vinegar-eels (*Anguillula aceti*), as they are called, are developed in most fruits, and hence readily find their way into vinegar made from fruit-juices. Vinegar which contains them must contain also as impurity some mucilaginous or albuminous matter, or the eels would have no food and could not exist. They need air also, and they have been observed engaged in a curious struggle with the mycoderm on the surface. The plant tends to prevent their obtaining the requisite supply of air, and the eels were seen combining their efforts to submerge it. They may be killed by heating the vinegar to 128° Fahr., or by adding boracic acid. Vinegar when long kept, especially if exposed to the air, putrefies and becomes ropy, losing its acidity, and acquiring an unpleasant smell; the presence of the vinegar-plant, vinegar-eels, or other foreign substances, is liable to induce putrefaction, especially if the vinegar is weak.

THE WEEK OF SEVEN DAYS.

By THE BISHOP OF CARLISLE.

IF a being from another world, suddenly placed among us, should examine terrestrial institutions, he could scarcely fail to inquire why it is that in so large a portion of the earth time is measured by periods of seven days. To a large number of persons among ourselves such inquiry is practically superseded by the consideration that the Bible opens with the recognition of the week: whatever discussion may be raised, and whatever may be the demands of science with reference to the interpretation of the commencement of the book of Genesis, the fact remains that it is asserted that in six days God created the heaven and the earth, and all things in them, and rested on the seventh day. The same assertion is renewed by the fourth commandment, which enjoins the keeping holy of the Sabbath-day. And when we remember how thoroughly the sanctification of one day in seven has been adopted and enforced by the practice of the Christian Church, and how the first day has been marked, in virtue of the chief article of Christian faith, as emphatically the *Lord's Day*, we can not be surprised to find that with most persons any speculation which transcends the limits of the facts just noticed is likely to meet with small encouragement.

Nevertheless, when we observe the necessarily hyper-historical character (if I may coin such a phrase) of the Mosaic cosmogony, as it is sometimes called; when we perceive, as we must upon consideration, the impossibility of interpreting the sacred narrative without some reference to the knowledge already possessed by those to whom it was given—we shall probably come to the conclusion that the reference to the creative work and the seventh day's rest of God does not exhaust the question of the existence of a seven days' week. Therefore, as it is manifestly impossible to detach the ordinary week of a large portion of the world from the history contained in Genesis, and as it is equally impossible to find in that history a complete explanation of the phenomenon, I have thought it might be interesting to examine the subject a little more closely, and see what light can be thrown upon it.

I begin my investigation with a few remarks upon what may be described as *favorite numbers.* There are certain numbers with which we meet more frequently than others, and of which we make more use in dealing with common things. The most favorite may, perhaps, be said to be *ten*, *twelve*, and *seven.*

The reason why *ten* is a favorite—perhaps the most favorite—number is obvious enough, namely, that we have ten fingers. When we begin to count we almost of necessity do so with our fingers; if we have a large number of things to count, say a flock of sheep,* we instinctively divide them into *tens*, or perhaps into *scores;* if the number of things be very large, the collection of tens are naturally grouped again by tens, and so we have hundreds. A further grouping of hundreds leads to thousands, etc. Thus we get the ordinary system of enumeration, and there can be no manner of doubt that man's ten fingers are the root of it. We are told in treatises on arithmetic that it would have been much more convenient if we had agreed to count by twelves instead of by tens; and possibly this may be true. But if it be, we have so much the more evidence, if evidence

* I have taken the counting of sheep as an example, not merely because such counting would necessarily take place in the earliest times, but also because we happen to know that the reckoning of sheep by tens or by scores was effected in olden days, and is effected still in many places far distant from each other, by the help of numerals, which appear to be appropriated to this sole purpose. In a paper headed "Sheep-scoring Numerals," and published in vol. iii, p. 385 of the "Transactions of the Cumberland and Westmoreland Antiquarian and Archæological Society," may be found no less than fifteen varieties of these sheep-scoring numerals as used in Coniston, Borrowdale, Millom, Eskdale (Cumberland), Kirkby Stephen, Epping, Knaresborough, Middleton (Durham), Cornwall, Brittany; in Hebron, Maine, and Cincinnati, among the North American Indians; and in some other places. There is a curious resemblance among the greater number of these numerals, and they all agree in counting by ten.

be needed, that the basis of the system of counting was not determined by theoretical considerations, but by the simple elementary fact of the number of human digits being *ten* and not *twelve*.*

Nevertheless twelve has its turn as a favorite number; we often count by dozens, and the reason probably is that twelve admits of being quartered as well as halved, which in many cases is an advantage. Take the case of wine: a dozen bottles is a convenient quantity to take as a standard, because a customer can order half the standard number, or, if he needs a small quantity, the quarter of the same; in fact, twelve admits of being divided not only by two and four, but also by three and six, which for many purposes give it a great advantage over ten, which can be divided only by two and five, the latter division being rarely of any use. Hence the great divisibility of twelve is sufficient to mark it as a favorite number, but in the most notable instance of its use—namely, as marking the number of months in a year—we need some further explanation. The real month—that is, the number of days between two successive full moons—may be taken as measured by twenty-eight days. Thirteen times twenty-eight makes three hundred and sixty four, or as nearly as may be one year. Consequently, it would have been much more nearly true to say that thirteen months make a year than twelve. The explanation is to be found, I conceive, in the extremely awkward character of the number thirteen; it is what is called by mathematicians a *prime* number; that is to say, it admits of no division of any kind: had there been thirteen months in the year, the half-year and the quarter alike could not have been reckoned by months, and consequently twelve, which, as already explained, is one of the most convenient of numbers in the matter of divisibility, was encouraged and permitted to usurp the place, which, in all strictness, belonged to its next-door neighbor.

There is a somewhat parallel case with regard to the division of the circle into 360 degrees. The ancient Chinese mathematicians divided the circle into $365\frac{1}{4}$ degrees, corresponding to the length of the year, or $365\frac{1}{4}$ days, which number, though not exact, is very near the truth.† But this division of the circle is practically intolerable; it would throw mathematicians into despair; consequently the number 360, which admits of being divided by 4, by 60, by 90, and by many other numbers, ursurped the place which the Chinese righteously assigned to the awkward number which Nature suggested.

I now pass on to the consideration of the number seven. It has

* The device of place, according to which the successive figures in writing numbers represent units, tens, hundreds, thousands, etc., as we proceed from right to left, is of Indian origin. The Romans, with all their practical cleverness, did not discover this simple and ingenious device; but they equally testify to the use of ten—or rather of five and ten—as the basis of calculation by their notation of numbers I, V, X, L, C.

† Biot, "Astronomie Physique," vol. i, p. 69.

no such obvious suggestion as ten, and no such recommendation of practical convenience as twelve; nevertheless, it is quite as truly a favorite number as either; perhaps, in some sense, it is more so. Its early occurrence in the book of Genesis might be adopted at once as an explanation of its prominence among numbers; this course of treatment, however, would not fall in with the intentions of this essay, and I shall therefore, in the first place, treat the subject in the most general manner possible, putting out of mind for the moment all thought of the references to the institution of the week which can be found in the Bible.

Adopting this course, we have to deal with the fact that the division of days by seven is both ancient and widespread. If, as has been held by good authorities, the method be of Chaldean origin, the notion that the number seven is connected with the heavenly bodies at once presents itself to our minds as probable; in fact, when we remember that to the early observers of the heavens the planets were seven in number—namely, the Sun, the Moon, Mercury, Venus, Mars, Jupiter, Saturn—and that the names of these planets were in divers countries connected with the several days of the week, the conclusion that the measuring of days by sevens took its rise from the physical fact that seven planetary bodies are visible to the naked eye must seem to be almost irresistible.

The reader may be referred upon this subject to a lucid article, s. v. "Week," in Smith's "Dictionary of the Bible." The writer says:

> Whether the week gave its sacredness to the number seven, or whether the ascendency of that number helped to determine the dimensions of the week, it is impossible to say. The latter fact—the ancient ascendency of the number seven—might rest upon divers grounds. The planets, according to the astronomy of those times, were seven in number; so are the notes of the diatonic scale; so also many other things naturally attracting observation.

And again:

> So far, then, the week being a division of time without ground in Nature, there was much to recommend its adoption. When the days were named from planetary deities, as among first the Assyrians and Chaldees, and then the Egyptians, then, of course, each period of seven days would constitute a whole, and that whole might come to be recognized by nations that disregarded or rejected the practice which had shaped and determined it. But, further, the week is a most natural and nearly exact quadri-partition of the month, so that the quarters of the moon may easily have suggested it.

The argument contained in these passages is somewhat weakened by the mixture of other considerations with those of an astronomical origin. The reference to the diatonic scale, for example, appears to be anything but a help—the more so, as the diatonic scale was unknown to the ancient people of the world, and is unrecognized in the East at the present time. Still more injurious is the indefinite reference to "many other things naturally attracting observation." The connection of the number seven as determining the division of time with celestial phenomena comes with a much greater air of probability when presented pure and simple: the rising and setting of the sun determined the days; the waxing and waning of the moon determined the months; and the position of the sun among the fixed stars divided the years. So that when it is suggested that the number of planetary bodies settled the length of the week, it is impossible to deny that the proposal comes before us with much *a priori* probability.

It is not necessary to refuse all sanction to the notion that the happy fact that $4 \times 7 = 28$, or that four weeks, each of seven days, roughly constitute a month, and that so, the artificial division of weeks had a convenient relation to the natural division of months, had something to do with stamping the number seven as the basis for the counting of days. Nor would it, perhaps, be possible to entirely deny the position of one who should argue that this convenient quadri-partition of the month was first in order of time, and that the dedication of the seven days of the week to the seven heavenly bodies followed afterward. I do not suspect that this actually was so; yet if it were asserted to be the more probable course of things, I do not know that the assertion could be positively disproved. But, whichever may have been the actual order of proceeding, what I desire now to enforce is equally true, namely, that the two astronomical considerations, namely, the number of planetary bodies known to the ancients and the period of the moon, may be regarded as co-operative, and as tending together to fix more distinctly the number of days in the week.

It would be entirely in accordance with the spirit of ancient religion, or superstition, to connect the days of the week, when once settled down to the number seven, with the thought of dedication to different deities, rather than with the mere fact of the existence of seven planetary bodies; and this state of things we find in the days of the week as used in the Roman Empire and among our Norse and Saxon ancestors. One may perhaps venture to guess that such an adaptation as this would naturally take place in any polytheistic country, which adopted the division of the days by seven; the more so, as several of the seven planets are not conspicuous as phenomena; and so the number seven, as derived from the heavens, would commend itself chiefly to the few who carefully observed, and would not be deeply impressed upon the people at large. The few would observe the planets, and dedicate the days to planetary deities; the many would know nothing about the planets, would regard the days as sacred to their gods.

Having thus far dealt with the week on general grounds, I now pass on to make some remarks upon it in connection with Holy Scripture.

In the first place, as has been remarked by the commentators, and as is apparent to careful readers, it would seem that some notion of the week of seven days was current among the people whose history is recorded in very early times; that is to say, at a date long preceding Moses or any of the books written by him. The proof of this is to be found in such passages as the following: Genesis xxix, 27, where Jacob is desired by Laban to "fulfill her week," that is, Leah's week, in order that he might also receive Rachel. The week appears to express the time given up to nuptial festivities. So afterward, in Judges xiv, where Samson speaks of "the seven days of the feast." So also on occasion of the death of Jacob, Joseph "made a mourning for his father seven days" (Genesis l, 10). But "neither of these instances," as remarked in the article to which reference has been already made, "any more than Noah's procedure in the ark, go further than showing the custom of observing a term of seven days for any observance of importance. They do not prove that the whole year, or the whole month, was thus divided at all times, and without regard to remarkable events." They do not, indeed, prove this, but they suggest the division as common and familiar, and in some early period recognized as an institution.

When, therefore, the children of Israel went down to Egypt for what proved to be a very long sojourn in that country, they possibly were familiar with the practice of dividing time by weeks, and at all events the notion of seven days as a convenient portion of time for the affairs of life would not seem altogether strange to them. It is exceedingly probable that on arriving in Egypt they found the week established by the practice of the country. It will be observed that it was in Egypt that Joseph mourned seven days for Jacob; and it is possible, though there seems to be no necessity to assume the fact, that in so doing he was conforming to the custom of the country, as he did with regard to the embalming and chesting of his father's remains. But independently of any such consideration, it would seem highly probable that the Israelites found themselves in Egypt among a people who divided the time by weeks of seven days. We know that they did so at a later period; why might they not have commenced as early as before the sojourn of the Israelites? The Egyptians were in fact a people very likely to be advanced in such a matter as this; order and government, both ecclesiastical and civil, were undoubtedly in a remarkable state of perfection at the time to which reference is now made; and it would seem much more probable than otherwise that so convenient an institution as the subdivision of the month into short periods had already been established.

It may be noted, with reference to the number seven and its recognition in some form or another as a special number among the Egyptians, that we have incidental evidence in the dream of Pharaoh; the special form of the dream, as presenting seven fat and seven lean kine, may be supposed to have been connected with some familiarity in Pharaoh's mind with the number seven during his waking hours.

And as regards the Israelites, it may be observed that the period of seven days is introduced into the most solemn event of their Egyptian sojourn, namely, the ordinance of the Passover: "Seven days shall ye eat unleavened bread; even the first day ye shall put away leaven out of your houses, for whosoever eateth leavened bread from the first day until the seventh day, that soul shall be cut off from Israel. And in the first day there shall be an holy convocation; and in the seventh day there shall be an holy convocation to you; no manner of work shall be done in them, save that which every man must eat, that only shall be done of you" (Exodus xii, 15, 16). And a little farther on, in the chapter from which the preceding passage is quoted, there is an apparent reference to the division of the month into four weeks, as the recognized method of division: "In the first month, on the fourteenth day of the month at even, ye shall eat unleavened bread, until the one-and-twentieth day of the month at even. Seven days shall there be no leaven found in your houses" (Exodus xii, 18, 19). Here we have seven mentioned as well as its multiples: seven, fourteen, twenty-one, and the month or twenty-eight days. It is difficult not to believe that either in consequence of Egyptian custom, or their old Syrian tradition, or both combined, the Israelites were at this time familiar with the notion of a week of seven days.

But there is evidence that not only was the week known to the Israelites, but also the ordinance of the Sabbath, early in their wanderings. The Sabbath does not appear to have been ordained for the first time when promulgated from Sinai. In Exodus xvi we read concerning the manna, "To-morrow is the rest of the holy Sabbath unto the Lord." Again: "Moses said, Eat that to-day; for to-day is a Sabbath unto the Lord; to-day ye shall not find it in the field; six days ye shall gather it, but on the seventh day, which is the Sabbath, in it there shall be none." And, once more: "See, too, that the Lord hath given you the Sabbath, therefore he giveth you on the sixth day the bread of two days; abide ye every man in his place; let no man go out of his place on the seventh day. So the people rested on the seventh day." Thus the promulgation from Sinai was only the republication, and confirming by more solemn sanction, of that which existed already. It should be observed, however, that the appointment of the Sabbath and the institution of the week are two different things: the week might be, and perhaps originally was, a merely secular division of time, like the month and the year; what was done by the teaching connected with the manna, and subsequently more explicitly by the fourth commandment, was to take one day out of the seven and impress a peculiar character upon it. Man, so to speak, made the week, but God made the Sabbath: the week was secular, the Sabbath was religious. If I may venture so to express myself, the task of Moses in forming his horde of Egyptian slaves into "a holy nation, a peculiar people," was a good deal facilitated by this course of proceeding; if the people, when, in God's providence, he first took them in hand, had been simple barbarians, having no measure of time but the phases of the moon, it would manifestly have been less easy to secure for rest and for religious purposes each seventh day. Why each seventh day? Why not the fourth or the fourteenth? But if the people had their almanac ready-made, and if they had been accustomed in Egypt to measure the time by weeks and to find each day of the week as weary as the rest under their cruel taskmasters, they would readily accept and rejoice in a law which made the concluding day of each week a day of rest and rejoicing. And in fact we find in the Deuteronomy version of the fourth commandment this pertinent exhortation: "Remember that thou wast a servant in the land of Egypt, and the Lord thy God brought thee out thence through a mighty hand, and by a stretched-out arm: therefore the Lord thy God commanded thee to keep the Sabbath-day" (Deuteronomy v, xv).

Let us now turn for a moment to this same commandment as we find it in the twentieth chapter of Exodus, and as it is commonly cited. The most remarkable feature in the commandment, as here given, is the reference to the six days' work and the seventh-day rest of the Almighty Creator. Upon this work of the creative week I shall have more to say hereafter; but at present let me observe that the form of the commandment, beginning "Remember the Sabbath-day to keep it holy," seems to imply that previous knowledge of the week and the Sabbath, of which we have already found evidence. It is very unlikely that the notion of a seventh-day Sabbath would have been announced for the first time in such fashion; in fact, we have already met with distinct teaching on the subject. Let it be added, however, that it has been supposed, and the supposition is reasonable, that the argument for keeping holy the Sabbath-day, founded upon the history of the Creation, which appears in the twentieth chapter of Exodus, does not belong to the original form of the commandment. The fact of its omission in Deuteronomy, and the addition in that version of the commandments of an appendix to the law of the Sabbath-day, which does not appear in Exodus, seems to set us free to suppose that both the one addition and the other were made subsequently, and did not belong to the commandment when given from Sinai. Indeed, there is much internal probability to recommend the suggestion of Ewald (approved by Canon Cook in the "Speaker's Commentary" as "deserving respect"), that the ten commandments were originally given in the following terse form:

1. Thou shalt have none other God before me.
2. Thou shalt not make to thee any graven image.
3. Thou shalt not take the name of Jehovah thy God in vain.
4. Thou shalt remember the Sabbath-day to keep it holy.
5. Thou shalt honor thy father and thy mother.
6. Thou shalt not kill.

7. Thou shalt not commit adultery.
8. Thou shalt not steal.
9. Thou shalt not bear false witness.
10. Thou shalt not covet.

Certainly, so far as the fourth commandment is concerned, it is highly improbable that in its original promulgation it should have been enforced by an argument depending upon knowledge of the creative week, contained in a book, of the existence and publication of which at that time there is no kind of evidence.

I lay stress upon this point, because I believe, and desire to suggest to the reader, that the actual history of the week and of the Sabbath is by no means that which the mere reading of the Bible, commencing with the first chapter of Genesis, might suggest to our minds. The book of Genesis describes the first condition of things, and speaks of the Creator as having spent six days in making the universe, and as having then rested on the seventh day, and having hallowed it; from which description it might seem natural to infer that we have here the history of the institution of the week and of the Sabbath as the close of it; and there are in fact writers who suggest that this institution was delivered to Adam, and came down from him by tradition to subsequent generations of men. Thus, in the "Speaker's Commentary," on the words of Genesis ii, 1, "*God blessed the seventh day,*" Bishop Harold Browne remarks, "The natural interpretation of these words is that the blessing of the Sabbath was immediately consequent on that first creation of man, for whom the Sabbath was made." This may be so; but when we endeavor to realize what is meant by the creation of man and the institution of the Sabbath being coeval, it is difficult to express the meaning in intelligible language. The keeping of the seventh day as a day of rest, involves the counting of six days, and then the dealing with the seventh day in some manner different from that in which the first six have been dealt with. Can we quite conceive of such a course in the case of the first man? Supposing him to have come into instantaneous existence in all the perfection of his human intelligence—a supposition which is beset with difficulties and is opposed to the belief of almost all who have studied the subject—is it possible to conceive of the newly formed man as at once comprehending the division of days into weeks, and the consecration of one day above another; or is it possible to conceive of him as capable of receiving a revelation which should convey this knowledge to his mind? If, as all the phenomena of history and of science indicate, the growth of man in knowledge of all kinds has been slow and gradual, then it must be reckoned as incredible that so refined and comparatively complicated arrangement as the division of time by weeks and the keeping of a Sabbath should have been the property of the earliest representative of our race.

So far as Holy Scripture itself is concerned, it will be observed that it is nowhere hinted that Adam had the knowledge imputed to him. The hints of something resembling the knowledge in patriarchal times have been already noticed, but these may very well be explained by reference to the natural growth of human knowledge, rather than to the hypothesis of a primeval tradition.

Having laid the foundations which are to be found in the previous part of this paper, I now address myself to the consideration of the week as we find it in the opening of the book of Genesis.

I propose to argue that the week did not take its rise from the sacred history, but that, contrariwise, the form in which that history was cast depended upon the knowledge possessed by the writer of the division of time by weeks, and of the institution of the Sabbath.

It will probably be admitted by all that the account of the creation given in the book of Genesis was not the result of scientific investigation. I am not wishing to raise the old question how far the account is consistent with scientific truth—this question does not now concern us—but am only asserting that the creative history can not be regarded in the same manner as that in which we regard a scientific treatise. It is either a speculation, or a poetical picture, or the record of a vision accorded to some gifted seer. Whichever it be, when the author of the written document which we possess came to put down in words his speculation, or his poem, or his vision, he would have to consider, or rather he would instinctively know, what kind of framework he should adopt in order to convey his thoughts to others. Compare the case of Moses, or the author of the original document which Moses used, with that of St. John the Divine. In the Apocalypse St. John speaks of things which he saw in his vision: there were candlesticks, and thrones, and choirs clothed in white garments, and the city of Jerusalem, etc.; all these were things with which he was familiar, and so his vision adapted itself to and formed itself upon these familiar things. No one will for one moment maintain the objective existence of these earthly things in that heaven into which St. John was permitted to peep through the open door; the vision was, in fact, of necessity to a great extent subjective; it is of the very nature of visions that this should be so. If, therefore, a vision of so absolutely transcendental an event as the creation of the universe be permitted to the mental eye of mortal man, that vision, when imparted to others, must clothe itself in such knowledge as the man himself possesses. And as the man, when he comes to record his vision, will instinctively use his own language—Hebrew, Greek, Latin, whatever it may be—to express himself, so also all other furniture of his mind will be naturally put into requisition in order to describe what he has seen.

This being conceded, let us suppose Moses himself to have been the speculator, poet, or seer to whom the vision of creation was for the first time vouchsafed, and let us suppose that the division of time by weeks was a matter of familiar knowledge to Moses. Then, this being so, it is quite intelligible that the successive works of creation, beginning with light and culminating in man, should fit themselves, as it were, into the framework which the division of the week supplied. *Some* framework would manifestly be required, and *this* framework would be ready-made.

There would be an advantage in this presentation of the week, which would be analogous to that which belonged to the whole Mosaic cosmogony, as a testimony against idolatry. The tendency, to which the nations almost universally fell victims, was to worship the heavenly bodies; but the story of creation, as given to the ancient church, distinctly asserted the creature character of these bodies, and with great and emphatic distinctiveness man's superiority to them all; the first chapter of Genesis was an eloquent protest against the worship of the host of heaven; and so, if there was a tendency to connect the days of the week with this same kind of false worship, by giving one day to the sun, another to the moon, and so on, nothing could more effectually cure this error than the appropriation of the days as representative of the stages of operation in the creative work of the one supreme God. The days did not belong to the planets, owed no allegiance to them, and were not influenced by them, however it might be true that the method of reckoning them was due to the number of these bodies; they were simply the first, second, third . . . days; all were alike except the seventh, upon which a special character was impressed. And it may be remarked in this connection that the Israelites never adopted the heathen practice, almost if not quite universal, of designating the days of the week by the names of the planets or of deities; to an Israelite Sunday was the first day of the week, and nothing more; the seventh day was the Sabbath, and the sixth was the day of preparation, but no taint could be found the whole week through of anything which could be twisted or perverted to idolatrous ends. The Christian Church has not thought it necessary to take so much precaution; bearing in mind that through her Lord the idols have been "utterly abolished," she has not feared to suffer to remain in her nomenclature some of the relics of the heathen past. When the Society of Friends endeavored to substitute the Jewish system for that which is current in Christendom, it was felt that the effort was unnecessary and unprofitable, and it has consequently failed outside their own body. The mongrel method of denoting the days of the week, which prevails throughout Europe, varying from one country to another, but mongrel in all, can not be defended upon any except antiquarian principles, but may be acknowledged to be free in common use from all taint of superstition or any danger of bringing in idolatry.

I shall be quite prepared to find that the view which has been taken in this essay of the relation of the seven days of Genesis to the seven ancient planets, will by some be regarded as objectionable, on the ground that it appears to conflict with what appears to such persons to be the literal interpretation of Holy Scripture. It may be said that the sacred writer plainly informs us that God created the universe, the planets included, in six days, and rested on the seventh, and that the number of these days can, therefore, have no dependence on the heavenly bodies which were created upon one of the days. And I quite admit that this kind of difficulty is *prima facie* very plausible; I have felt it strongly myself; I do not wonder that others should feel it. But it may be observed that, when we speak of the "literal interpretation" of this portion of Holy Scripture, we are using language which, when examined, has no definite meaning. The whole history of creation is necessarily supra-literal. "The Spirit of God moved upon the face of the waters." What *literal* meaning is there here? "God said, Let there be light, and there was light." How can this grand description be taken *literally?* "God said, Let us make man in our image, after our likeness." How can we assign to such transcendental language any sense which can properly be called *literal?* And so on throughout the whole creative history. Consequently the literal theory must be simply and completely given up, as in the very nature of things impossible; and the question arises, What shall we put in its place? The answer seems to be, that such a picture or sketch of the origin of things was accorded to the sacred writer, and placed at the head of Holy Scripture, as was fitted to the comprehension of man, and fitted to introduce the subsequent portions of the Word of God. The tenacity with which a large number of persons adhere to what they regard as the "literal meaning" of the first chapter of Genesis, proves with what wonderful skill the chapter has been written; but when we come to consider what the literal meaning of the phrase "literal meaning" is, we find that the words are in their nature totally inapplicable to such a composition as that with which we are dealing; and having realized this fact, we may, perhaps, find that there is another mode of interpretation which is more reasonable, more free from difficulties, and which yet deprives the sacred narrative of no particle of its meaning. To supply such a mode of interpretation is the purpose of this essay; if any of those who read it find that it has thrown light upon a dark subject, and assisted them to see their way through a difficulty connected with Holy Scripture, my purpose in writing it will have been abundantly accomplished.*—*Contemporary Review.*

* Nothing that is here said contradicts the principle of St. Augustine's treatise, "De Genesi ad Litteram." The *literal* meaning, in St. Augustine's sense, is in antithesis to the *spiritual* or *allegorical.* I do not think that the great Christian philosopher would have found fault with the views contained in this paper.

THE VOICES OF ANIMALS.

By DETLEV VON GEYERN.

THE whole world is one wondrous blending of the most varied voices, flowing together and intermingling. This unison of sound forms the great tone of life on our globe, and chimes in harmoniously with the poets' and philosophers' music of the spheres. The existence of such a music is not to be denied, even from a purely realistic point of view. If from a distance one were to listen to the thousand noises and sounds of all kinds that arise from the throbbing of life in a large town, these all would seemingly be lost in one low hum resembling the vibrations of a huge tuning-fork, and appearing as but a single tone. Even thus the entire volume of sound coming from our planet would seem as a single tone to one soaring far above the earth, and capable of hearing through vast distances. Similar sounds would arise from other worlds and thus would be produced a veritable music of the spheres, sounding on into the infinite.

Bernardin de St. Pierre has written a very curious book on the harmonies of Nature. Palissy has made numerous ingenious observations on the melodies of plants and trees, which Lamartine, through his book on "Great Men," has rescued from oblivion.

It is a well-known fact that every metal has a sound peculiar to itself. So, too, the voices of animals have at all times played an important part in Nature—now looked upon by man with superstitious awe, and anon observed with the eye of Science.

In olden times the priests and the tillers of the soil were the ones to pay attention to the voices of animals—the priests, to be guided by them in their oracles; the peasants, to learn of changes in the weather and coming storms. It seems rather strange that the observation and the understanding of the voices of animals have become more and more of a lost art with the advance of civilization, so called; and it appears almost an anomaly that in these times a scholar like M. Louis Nicolardot, of Paris, should turn his attention, with all the thoroughness of science, yet in a most charming and entertaining manner, to a study of the voices of Nature. He has done this in a work entitled "La Fontaine and the Human Comedy."

La Fontaine endows Nature with the voice of man, to mirror the manners, the faults, and the vices of mankind. Nicolardot, however, has traced the true and real significance of the voices of Nature, and shows—at times in a surprising manner—that these voices of Nature often express more and bear a deeper meaning than even the fancy of the great fable-writers, from Æsop down to La Fontaine, has ascribed to them. It is very interesting to study more particularly the animal world with reference to its various voices, and to follow out the meaning of these voices in the great concert of Nature. As Nicolardot has ascertained, there is more dumbness in the animal world than is generally supposed. This dumbness, however, is rarely absolute, but rather more an inability to form articulated sounds.

Every animal of the higher orders is possessed of some sort of tone expressive of pain or joy, and by means of this it can make itself understood by its kind. Fish can produce no sound in the water, because air is lacking as a medium to propagate the waves of sound; and yet we incline to the belief that the water itself may admit of the forming of some kind of sound-waves, which the fish perhaps may be capable of exciting, and which will be experienced and comprehended by other fish. As far as we are concerned, of course, fish will remain mute, as the element in which they live is one into whose conditions of existence we may never enter, and that to us means death. But even among our domestic animals, the dog heading the list, there reigns, to our ear at least, a dumbness well-nigh absolute, broken only occasionally by faint and forcibly uttered sounds. In very cold and in very hot climates there are certain dog races that never bark, a fact already referred to by Captain Cook in the account of his voyages. In Asia there is a species of dog called *colsuns* which never barks. It is to be found chiefly in the Deccan, in the mountains of Nilgiri and in the woodlands on the coast of Coromandel. Also among the birds, by poets so often styled "the singers of the forest," there are many kinds that are mute. Two varieties of sparrows, the *tangara* of Brazil and the *senegali* at the Senegal, are said never to emit a sound; and in Australia there are larks quite similar to those of our own country, but which never sing.

The real singing of birds is done only in spring-time, to greet anew Nature's awakening. During the rest of the year even the best singers of the woods confine themselves to simple chirping notes of woe or joy. Nicolardot believes that the song of birds may be regarded as the original fount of all music, and according to his view each musical instrument was originally only devised to imitate the voice of some bird. Bringing to bear a considerable knowledge of natural history and perhaps an equal amount of charming fancy, he traces the whole orchestra of to-day back to the voices of birds. He demonstrates that for every instrument—the clarionet, the flute, the oboe, the trombone, the trumpet, and all the rest—a bird may be named that bears the fundamental tone of such instrument in its throat, and which has been copied by man in the making of the instrument. To the nightingale he assigns in this bird-orchestra the part of the organ, and even the rattling of the castanets he would trace to the peculiar noise made by some birds of prey with their bill.

Besides their songs with which they greet Spring, and their notes of pain and joy, birds have still other sounds which they use only on certain occasions. Many birds, besides the rooster, herald the early dawn and sunrise with certain peculiar notes. Among these are the lark, the linnet, the curlew, the plover, the lapwing, and the bittern. Quite a number of birds announce the coming of rain; for instance, the magpie, the owl, the yellow thrush, and the greenfinch. This is also done by means of peculiar notes which they never sound on other occasions. Nicolardot has essayed to reproduce these notes by letters. There also are storm-birds, so-called *procellaria*, which in a similar manner—that is to say, by the use of certain peculiar sounds—predict the coming of a storm, even a long time in advance. Domestic fowl are often watchful for strangers; especially is this the case with peacocks, who are pretty sure to announce by cries the approach of strangers to house or farm.

Birds thus can feel and announce the coming of rain and storm, and already the ancients ascribed to them the faculty of prediction. In their flight and in their voices indications of coming events were sought. The augurs of old had established a whole science of the flight and the voices of birds. Nor is it improbable that training was resorted to, to aid in procuring such predictions—that is to say, to create favorable or unfavorable omens, whichever might happen to best suit the plans of the priests at the time.

Louis Napoleon, in our nineteenth century, intended to convince the French people, by the aid of a trained eagle which was to have alighted on his head at the right moment, that he was the predestined successor to his great uncle. Nicolardot does not go quite so far as the augurs of the ancients, but he also ascribes to birds a prescience of coming events, especially of approaching misfortune, to which feeling they lend expression by certain peculiar sounds. As an example he cites a tale from O'Meara's "Voice from St. Helena." When the French entered Moscow, this author relates, a great flock of ravens came and settled on the towers of the Kremlin. From there these birds, to which the ancients ascribed great sagacity, came flying down close to the heads of the soldiers, flapped their wings, and kept up a continuous, monotonous croaking. The troops were much disheartened by this occurrence, and feared misfortune. Shortly before the terrible conflagration broke out, all the ravens had disappeared, flying away in great numbers.

Napoleon I paid considerable attention to the voices of animals. O'Meara cites the following from a conversation of the emperor's: "How can we know that the animals have not a language of their own? Does it not seem to be very presuming on our part to deny the existence of such a language, simply because we do not understand it? We know that a horse has a memory, that it can make distinctions, that it shows antipathy and sympathy; it knows its master, and can tell him from the servants, although it sees the master but rarely, and has the grooms for company throughout the day." The emperor related that he had once owned a horse which always succeeded in finding him even when he had hidden among other people. This animal always showed his joy whenever the emperor mounted him. He would permit but one groom in whose care he was placed to get on his back, but, when this groom was the rider, the whole bearing and movements of the horse were different from what they were when the emperor rode him. In the former case the horse seemed to be fully conscious that his rider was but a subordinate. When the emperor had lost his way while out riding or hunting, he simply placed the reins on the neck of this horse, and he had always speedily and surely found the right way. Whenever the emperor approached, the horse gave expression to his joy by a special sort of neighing, and often it had seemed to Napoleon as if the animal were trying to tell him something. Nicolardot, basing his assertion on experience, maintains that each animal has a language of its own, and that it is simply due to the imperfection of our organs that we do not understand this language. In this connection we would mention that Kasper Hauser, the well-known foundling, who had eaten no meat up to his twenty-first year, insisted at the time, shortly after he was found, and before he had grown accustomed to animal food, that he understood the language of all animals, and that very often, when a dog barked or a bird chirped, he knew exactly what was meant. The animals approached him without fear, and seemed to be conscious that he could understand them, but this all came to an end when he began to take animal food. Hence, it might be inferred that the eating of meat tends to remove us from the animal world and to weaken our understanding of its ways. But, if we turn our whole attention to animals, our superior intellect will soon place us in the way of understanding their language.

About 1770 Galliani had two cats which he always kept about him, and away from all other animals. He states that he understood them perfectly, and that they had a complete language of their own in which they always expressed the same wish and the same feeling by exactly the same sound. Lucian observed the common house-fly, and also maintains that this insect, so greatly despised and persecuted, possesses a complete language—that is to say, uses certain sounds in its buzzing to denote certain things, and in this way makes itself understood among kind. Lamartine, in his descriptions of travels in the East, tells of Arabian horses that used certain definite sounds to express certain things, just as Napoleon relates of his steed.

Birds, in addition to the sounds peculiar to them, are gifted with a great talent for imitation. There is hardly a bird, provided it has any voice at all, that can not imitate, at least to a certain extent, the sounds of Nature. Birds attempt to imitate each other, the voices of other animals, and in fact all possible sounds. Parrots are able to make a noise like that produced by a saw, the sound of a cork drawn from a bottle, and other noises still more peculiar. The mocking-bird is a perfect plagiarist in the feathered world; he imitates almost all songsters, even the nightingale. The kingfisher can reproduce most accurately the cackling of hens, the barking of dogs, the quacking of ducks, and the bleating of sheep. Birds as well as mankind are apt to be vain of their voices and seek to excel one another. Especially is this the case with nightingales. In a hedge inhabited by them one may often observe that their voices increase two, ay, threefold in strength, and sometimes some of these birds are found with their throats torn—they have simply sung themselves to death! But not only in music have birds been the model followed by man, but also that peculiar and entertaining art, ventriloquism, has been copied from them. Just as many of them sing out boldly and fill the air with their melodies, others form their sounds without opening their bills. The pigeon is a well-known instance of this; its cooing can be distinctly heard, although it does not open its bill; the call is formed internally in the throat and chest, and is only rendered audible by resonance. Similar ways may be observed in many birds and other animals. The clear, loud call of the cuckoo is, according to Nicolardot, only the resonance of a note formed in the bird. The whirring of the snipe, which betrays the approach of the bird to the hunter, is an act of ventriloquism. The frog also is said not to open his mouth in croaking, but to create his far-reaching sounds by the rolling of air in his intestines. Even the nightingale has certain notes which are produced internally, and which are audible while the bill is closed. So even the art of ventriloquism (if we may call it an art), which is nowadays but little practiced, but which in former times was highly esteemed, has been taught to man by the animals.

Human society seems attractive to birds, as Nicolardot proves by numerous instances; especially have song-birds a great fondness for human dwellings, and rarely do they go far away from them. It almost seems as if they were vain of the admiration bestowed on their song. They lay and hatch better in parks than in woods. Nicolardot says that the cuckoo, the crow, the quail, and the lark, never live in districts entirely untenanted by man. There are quite a number of city and village birds which always settle in the immediate neighborhood of human dwellings. Among these are the starling, the nightingale, the finch, and the sparrow, but above all the stork. All of these birds are said to imitate, by their calls or their song, the human voice, or else noises which are to be heard about dwellings. For instance, it is said that the stork in Africa—though this we would not like to vouch for—is dumb, and that his clappering here is but an imitation of the sharpening of scythes. This sound is supposed to be specially pleasing to the stork, because on freshly cut meadows he always finds food in plenty, and therefore it is presumed that he imitates this noise as suggestive of a rich dinner. All of these birds show great fondness for, and are said to be capable of imitating, the human voice, if one were only to take sufficient pains in training them. And, more than this, they can repeat entire words like the parrot. That starlings and ravens can talk is a well-known fact, but instances are known where other kinds of birds have learned to speak. Russ, for instance, in his book on ornithology, tells about a canary, owned by an actress, which was capable of speaking some words distinctly.

Other birds have a special liking for certain sounds—owls, for instance, like the tolling of bells. Nicolardot says that a special variety of owl, the "tower-owl," which preferably nests in bell-towers of churches, closely imitates in its cry the sound given out by bells. He also states that it is a comparatively easy matter, calling only for a little trouble and patience, to teach the greenfinch and the yellow thrush to talk. Song-birds especially are said to be capable of a musical education much more extensive than they commonly receive nowadays. They are said not only to be able to repeat short melodies whistled to them, but also to sing to the accompaniment of instruments. Maximus, of Tyre, relates, in his "Philosophical Conversations" (translated by Torme), that a certain man, who devoted much of his time and attention to animals, had kept a number of birds of different kinds in his room. Every morning during the beginning of their captivity they sang and chirped—each in its own way—giving rise to much noise and great confusion. In a comparatively short time, however, this man had succeeded in training his birds so that they joined him in making music. He played the flute, and the birds accompanied his playing with their voices, at certain passages all singing correctly in chorus. The responsibility for the truth of this story we must leave to the narrator; however, it is a fact that, in the musical training of birds, wonderful things may be done.

During the time of Napoleon III, there was at Paris a so-called *charmeur* who came every noon into the garden of the Tuileries and fed the birds of all kinds. The animals knew him by sight, and came to him at once. He could call them individually, and they would perch on his fingers, and, if he whistled certain signal-notes for them, they would repeat these clearly and distinctly.

In these days we are ever seeking and searching; we penetrate deeply into all domains of Nature, and believe ourselves to be approaching to a more true conception of the world about us. But rarely has it been seriously attempted to study the voices of Nature, which form so important a chord in the great concert of creation. Undoubtedly there is here yet much that lies unrevealed, and that is well worth attentive study and investigation. Perchance this might lead to important conclusions concerning the great secret of life in its organic function, which nowhere draws a sharp line between the animal and the vegetable kingdom, and which joins the latter by insensible gradations to the mineral world. The first attempt in this direction has been made by Nicolardot with his work, and this well merits our interest and appreciation.—*Translated for the Popular Science Monthly from Ueber Land und Meer.*

SKETCH OF NICHOLAS PREJEVALSKI.

THE Russian explorer, Prejevalski, had returned, at the beginning of 1886, from his fourth journey of scientific investigation and military reconnaissance in Central Asia. His activity and its fruitfulness in the extension of knowledge are truly wonderful.

Nicholas Prejevalski is now in his forty-seventh year, having been born on the 31st of March, 1839. He was the son of an old Polish landholder in the province of Smolensk. Having attended the gymnasium of his native province for a time, he entered the Military Academy in St. Petersburg, and devoted himself to the natural sciences. He was engaged in the Polish campaign, and afterward resided at Warsaw, as teacher of history and geography, till 1867; then, at his own request, he was transferred to Irkutsk, in Eastern Siberia, whence he undertook journeys to the Amoor and Ussari. This remote region exercised such a power of fascination over the young man that the starting-point of his whole career may be dated from his residence there. It gave the first response to his natural taste for traveling in strange lands, and we therefore find it perfectly in course that he should have started in 1870 upon a longer journey through China. The expedition was undertaken under a commission from the Geographical Society of St. Petersburg, in company with Lieutenant Michael Pylzow and two Cossacks, and lasted three years. In its course it traversed Mongolia, Shan-Su, the basin of the Kuku-Nor, and Northern Thibet, for a distance of more than seven thousand miles. The literary fruit of this expedition was a book of "Travels in Mongolia in the Tangut Country, and the Solitudes of Northern Thibet, 1870–'73," which was published in London in 1876, translated by E. Delmar Morgan, and furnished with an introduction and notes by Colonel Henry Yule.

The journey was directed to the regions lying outside of the great Chinese wall, a country concerning which our data, derived chiefly from the accounts of Marco Polo in the thirteenth century and of a few missionaries, were so defective and inaccurate, that the whole table-land of Eastern Asia, extending from the Siberian mountains in the north to the Himalaya in the south, and from the Pamir Plain to China, was as little known to us as Central Africa or the interior of New Holland. This region, then a *terra incognita*, exceeding the whole of Eastern Europe in extent, situated, to borrow the words of the explorer, in the middle of the greatest continent, at an absolute height with which no other region on the globe could compare, here intersected by giant mountains, there spread out into illimitable desert plains, presented in every aspect features of scientific interest. But, he added, strongly as these regions attract us by the mysteries which they conceal, they equally deter us by the threat of all possible hardships. On one side looms up the desert, with its sand-storms, its dearth of water, its heat and cold; on another side, the European encounters a suspicious, barbarous people, who will meet him in ambush or be his open enemies. After three years of contention with these difficulties, he had the rare fortune of reaching the Kuku-Nor and the upper waters of the Yang-tse-Kiang River in Thibet. He had only to lament the insufficiency of his outfit, a matter of great importance in all explorations. Yet, with the means he had, he carried the line of his journey thirty-three hundred miles forward with the aid of a hand-compass, defined eighteen meridians on his map, and observed the magnetic variation at nine points and the horizontal deviation at seven. Meteorological observations were taken four times a day, the temperature of the ground was tested frequently, and hygrometric observations were taken several times. Special attention was given to physiographical investigations and the examination of the mammals and birds, and every opportunity for ethnographical research was improved. The expedition collected specimens of two hundred and thirty-eight species of birds, skins of forty-two species of mammals, a dozen amphibia, eleven species of fishes, and more than three thousand insects. These were all deposited in the Museum of the Academy of Sciences of St. Petersburg. The botanical collections, which were handed over to the Imperial Botanical Gardens, included some four thousand examples, of five or six hundred species. The mineralogical collection comprised small specimens from all the ranges that were crossed.

The route of this expedition was from Kiakhta to Peking, where the outfit was completed, thence along the southeastern border of the Mongolian table-land north of Peking to the city of Dolon-Nor, across the Dulai-Nor Lake to Kalgan and the Yellow River, and thence over an Alpine region and across the Hoang-ho to Ordos in its valley. From this place it went to the marshy Zaidemin Lake, and thence to the Ala-Shan, or the southwestern part of the Desert of Gobi, a barren region, inhabited by a Mongolian tribe, the Oleuts, and to the Ala-Shan Mountains, a range in places exceeding ten thousand feet in height, and which is the home of the musk-ox. High as these mountains are, they possess an abundant animal life. Unfortunately, the explorer's funds were exhausted at this point, and his pass from the Chinese Government extending only to the province of Shan-Su, there seemed to be no alternative but to retire to Kalgan in Southeastern Mongolia. The expedition returned along the left shore of the Yellow River, through the country of the Urotes, visiting on the way the great salt lake Jaratai Dabaru, whence salt is carried to China. The return was beset with many difficulties, but Kalgan was reached at last, and the first part of the expedition was completed, with results on the whole so satisfactory that the travelers, though still in the interior of Asia, determined to undertake a journey to the farther shore of the Kuku-Nor. It was however necessary, first, to go to Peking and obtain a new outfit. A new pass was granted by the Chinese Government, extending to the Kuku-Nor and the borders of Thibet, and, with two fresh Cossack guardsmen, Prejevalski started back by the same route by which he had come from Ala-Shan to Kalgan. The party had the good fortune to attach itself to a Tangut caravan, which was going to the monastery of Chobsen, within a short distance of the Kuku-Nor, and would be to it as the best of guides, and also a defense against the Dungans, who were making parts of the country very uncomfortable. Having crossed the wilderness of Ala-Shan, to the border ranges of Shan-Su, they came upon a mountain-region, where the high elevation of the land, frequently rising above the snow-line, gave an abrupt and remarkable change to the character of the landscape. Fields and forests were laid out before the explorers, and the flora and fauna offered so many attractions to them that they spent the summer there. These mountains, which the Chinese call Nan-Shan or Sue-Shan, consist of three parallel ranges, and constitute a wild Alpine region, in the forests of which the *Rheum palmatum*, or rhubarb, which was for the first time in modern history seen in its native region, is the characteristic plant, while the belt between twelve and thirteen thousand feet of altitude abounds in rhododendrons. The mountains rise to the height of fourteen thousand feet, but there are no woods on their southern slopes. The Dungans pass for their most savage inhabitants, but they were not bold enough, with all the advantages of numbers on their side to attack our four travelers. All dangers were avoided by watchful care; and at last Prejevalski, getting a view of the Kuku-Nor, was able to say, as he has written in his account of the journey: "The dream of my life was fulfilled; the long-sought end was reached. What I had just before only dreamed of, had now become reality. It is true that this result had been bought only at the cost of many hard trials, but now all the sufferings we had endured were forgotten, and, full of joy, my companions and I stood on the shores of the great lake, and enjoyed the sight of its marvelously deep-blue waters." On the 12th of October, 1872, he pitched his tent on the shore of the lake, ten thousand five hundred feet above the sea, being the first European who had visited it, except the Jesuit Father Huc. Thibet lay before him as a new object of research, and he hoped to pass over Thibetan land to the upper waters of the Blue River, or Yang-tse-Kiang. He started on the 18th of November, and penetrated into that land along the lofty pass, till he was only about five hundred miles from Lassa, the residence of the Dalai Lama. But, again, the want of money compelled him to turn back. He retired to Zaidam, on the Kuku-Nor, where he remained till spring. In May, 1873, he was again in the Desert of Ala-Shan, which he succeeded in crossing without a guide, and reached the city of Dyu-Yuan-in after a hazardous march of fifteen days from

Dajin. The people of this town, who had seen them before, complimented them on their having grown to look like themselves, or having become quite Mongolian. Prejevalski himself describes the party as exhausted by their arduous march, half starved, with ragged clothes and boots, looking like beggars. Here they entered upon the final stage of their journey through a land which no European had ever entered before them—the heart of the Desert of Gobi, a region "so terrible that, in comparison with it, the Desert of Northern Thibet may be called fruitful; there, at all events, you may find water and good pasture-land in the valleys; here there is neither one nor the other, not even a single oasis; everywhere the silence of the valley of death"—in order to reach the Russian city of Urga, on its border. Finally, Prejevalski reached Kiackta, his original starting-point, on the 19th of September, 1873.

Not satisfied with the results of this expedition, which he regarded as still incomplete, Prejevalsky engaged in the organization of a second one, to be more adequately prepared for its work, which he designated as intended for "a scientific reconnaissance of Central Asia." The objective points of this, his third journey into the interior of the continent, were the Lob-Nor, which no European had ever seen, and the exploration of Thibet. With two Russian companions he went to the valley of the Ili and to the Tarim River, by whose course he hoped to be led to the still mysterious lake. Hence his route was continued to the elevated Altyn-Dagh, the northern outpost of the Kuen-Lun, but he still failed to get into Thibet. To quote from his own narrative: "The examination of the Lob-Nor and of Western Dungaria formed the conclusion of my second expedition into inner Asia. I had, in consequence of the severity of my efforts, and by the operation of climatic influences, brought upon myself a grave illness, which compelled me, instead of returning to Thibet and Hami, to stop at the end of 1877 in our border post of Saisan. After three months of good care, I was restored enough to undertake a new journey. But the expedition was now postponed by an order from St. Petersburg, because of the unpleasant relations that were existing with the Chinese. The delay, however, had its pleasant features for me. I could go to my own home, and there, in the undisturbed quiet of a country life, gain a complete recovery. Here, in this season of rest, the importance of making the still wholly unknown wild regions of the interior of Asia the object of a journey of discovery became clearly fixed in my mind." Thus it came about that he particularly emphasized the exploration of Thibet. His plan was supported by the Geographical Society, and approved by the Minister of War, and he was allowed a subsidy of twenty-nine thousand rubles. His company consisted of twelve persons besides himself: Ensign Ecklon for the zoölogical and Ensign Roborowski for the botanical work; three soldiers and five Cossacks; a subordinate officer and *preparateur;* and an interpreter from Kuldja for the Turkish and Chinese languages, who had been with him to the Lob-Nor. The baggage, arranged in forty-six packages, was loaded upon twenty-three camels. It included two Mongolian tents and arms of the best manufacture, in the use of which the whole company was carefully drilled. The soldiers and Cossacks were accommodated upon eight camels, and there were four reserve camels. Prejevalski, with the officers and the interpreter, rode on horseback. The party left Saisank on March 21, 1879, directing their course toward the Dungarian Desert, between the Altai and the Thian-Shan. At the latter range the salt-steppes abruptly give way to fragrant forests of larch; the mountains assume a wonderful grandeur, lifting their tops away above the snow-line, and rising like a steep wall out of the plain. Along the northern and southern Thian-Shan extends one of the many oases which wind along like a tortuous chain between the Kuen-Lun, the Altyn-Dagh, and the Nan-Shan—the oasis of Hami in the desert of that name. Through this oasis and that of Sa-cheu, the party proceeded to the foot-hills of the Nan-Shan and into those lofty mountains themselves. Two of the snow-covered outposts of the range, about eighteen thousand five hundred feet high, were named after Humboldt and Ritter. Prejevalski then entered the extensive district of Zaidam, inhabited by Oleuts, where he had formerly sought for the Kuku-Nor. This time it was Northern Thibet, with its table-lands standing at an elevation of from twelve to sixteen thousand feet, and its mountains towering above all their neighbors, that stood foremost in his vision. On his first journey he had struck the route of the Buddhist pilgrims, and had reached the point where the Napchi-Ulan-Muren enters the Mur-Usu, which from there is called the Yang-tse-Kiang. On his second journey he had reached only the northern borders of Thibet. On this third journey he reached the sources of the Blue River (the Mur-Usu), on the Tan-la, and a portion of the Yellow River, and the Kuku-Nor. The significance of this achievement is explained by himself when he writes: "European travelers have to encounter great difficulties in these regions, arising out of climatological and local circumstances. The great absolute height and the consequent rarefaction of the air, with sharp changes of temperature, make the ascent of the pathless heights a toilsome work. The opposition of Nature has to be overcome at every forward step, and the traveler must at all times be prepared for hindrances and hostility of every kind from the people. Only by the application of one's entire physical strength and of extreme energy is it possible to overcome the impediments of these mountains." He left Zaidam on the 12th of September, 1879, taking a route between his old one, over the Burchan-Budda, and the Nomachun-Gol, and along the latter into the home of the yak and the antelope. He purposed to pursue a straight course for Lassa; and the character of his march is sufficiently described when it is said that, during all the time he was in Thibet, he never moved at a less altitude than thirteen thousand five hundred feet! To the difficulties afforded by the elevation were added attacks from predatory tribes, the Jegrais, which had to be repelled by fighting. He was not allowed to visit Lassa, although he was granted an interview with a deputation from the Holy City, who came to his camp at the foot of the Bumsa Mountain, sixteen thousand four hundred feet above the sea. "Again," he sorrowfully writes, "was my effort to penetrate to the capital of Thibet baffled by barbarian prejudices and the fanaticism of a stupid people. Now, when the greatest obstacles had been overcome, when everything had been smoothed away, when I had the object of my desires so near to my eye, I had again to turn back without accomplishing my purpose. It was a severe trial to give it up." He returned, through a moderately high spur of the Kuen-Lun range—which he named the Marco Polo Mountains, after the old Venetian traveler—and another unknown range, to Zaidam. On the 31st of January, 1880, after four and a half months of wandering in Thibet, he entered the station of Dsun-Lassak. This ended the second period of his expedition. The third period was passed in Zaidam, and partly in the Kuku-Nor, whence he undertook a journey of exploration to the sources of the Chuan-Chi, or Yellow River, which he followed from the Kuku-Nor southward into the northeastern spurs of the Thibetan foot-hills. He wanted to solve what had always been a riddle even to the Chinese. He returned to the Kuku-Nor, and struck from it upon the old road from Ala-Shan to Urga, which he had traversed in 1873. The fullest and most accurate information which geography has gained of the regions through which he traveled is what he has given it.

This journey was characterized by Dr. Petermann as the crown of Central Asiatic exploration, and as equal in importance to Stanley's journey down the Congo, or even to the attainment of the pole. Of its results, "Nature" said, in a summary of them, that the traveler's observations would be "of special value to the ethnologist, as containing important details concerning the various peoples he met with. The zoölogist and botanist will also find much to interest him." In its notice of the book, the same journal referred to the part of the narrative describing what the author observed during his stay at Lob-Nor concerning the migrations of birds as being of exceptional value. The Royal Geographical Society, in April, 1879, awarded a gold medal to Colonel Prejevalski, "for the great additions he has made to our knowledge of Central and Eastern High Asia, by his successive expeditions into the unexplored parts of the great plateau of Mongolia and the lofty deserts of Western Thibet, and for the admirable way in which he has described the regions traversed by him in the published narratives of his journeys."

No amount of adventure satisfies a traveler, and Prejevalski was not satisfied with the excursions he had already made. At the close of his book, describing his third expedition, he says: "The joy with which I again saw my home, after my tedious travels, may be easily comprehended. But the more that every-day life demands its rights, the more actively does the pressure toward the far-off deserts of Asia, which once seen can never be forgotten, the longing to visit them again, rise in my soul. Yes, in those deserts," he added, "an unlimited freedom reigns. The traveler stands opposing the wild robber-hordes with the weapons of science and civilization. The dangers which he encounters every day for his love of science are quickly forgotten, while the recollection of the moment of success and of real happiness remains fixed and clear in the mind. The picture of those past joys floats before him day and night, and entices him, even from the midst of the enjoyment of the rest of civilization, to that life of labor and freedom." This book was published in London in 1879 as "From Kuldja, across the Thian-Shan, to Lob-Nor," translated by Mr. Morgan, with an introduction by Sir Douglas Forsyth.

In 1883, Colonel Prejevalski went on his fourth expedition to the same regions, having the country of the Yellow River as his objective point. He started in November, and, traveling in a cold under which quicksilver was frozen, found himself in February, 1884, again in Thibet. In May he went down to the south of Zaidam, whence, having left his baggage with a guard of Cossacks, he started again for the sources of the Yellow River. They were found to lie in a region uninhabited by man, but peopled by innumerable herds of yaks. Thence he turned to the shores of the Blue River where he suffered an attack from hostile Tanguts. He repelled them, but they succeeded in preventing his crossing the river, and forced him to turn back. They continued to annoy him for several weeks, when he again went back to the headwaters of the Yellow River and the lakes by which it is fed. Leaving Southern Zaidam, he went westward with thirteen persons into a desert where even camels could not live. He came at last to the shore of an impenetrable swamp, which was well inhabited by pheasants. He remained for three months at a place called Gaz, whence he penetrated to a part of Western Thibet, where he discovered three previously unknown mountain-ranges. From Gaz the road went on through a labyrinth of narrow passes and defiles to the Turkoman town of Loto, where the population was friendly. The people of Western China, where it borders on East Turkistan, were likewise well disposed toward him. The country is described as being very attractive, without winter, populous, and as yielding two crops of grain a year.

Colonel Prejevalski's return from his fourth journey was celebrated at St. Petersburg by a special session of the Geographical Society, on the 10th of February, which was attended by members of the imperial family, ministers of state, diplomates, and learned men, all eager to pay their respects to the energetic traveler, who, on this occasion, was made a major-general.

CORRESPONDENCE.

A NOTE ON INDIAN CRANIOLOGY.

Messrs. Editors:

WILL you kindly allow me a few lines of your valuable space in the correspondence column of the "Monthly" for the purpose of correcting an error which you have made in noticing my memoir on "A Navajo Skull," on page 279 of the December (1886) issue of your journal, as well as to make a few comments thereon?

You have ascribed the authorship of my monograph on the Navajo skull to no less an eminent biologist and anthropologist than Sir William Turner, F. R. S., and, as much as I feel honored by your oversight, it had better perhaps be corrected to stand otherwise. Dr. Turner, indeed, is the author of the valuable "Additional Note on the Navajo Skull," which you properly attribute to him. It supplements my memoir and adds thereto information which, owing to my far removal from the literature of such subjects, I could not supply. Dr. Turner kindly rounded off my work for me, and both papers appeared together in the "Journal of Anatomy." He subsequently sent me a few "reprints" of his note, and I sent you a copy, so that you would have the case complete before you.

The only point that you call attention to in your December notice of the memoir in question is, that it relates "to the examination of the skull of a Navajo Indian of about forty years of age, who came to his death by a gunshot-wound of the head." As true as this undoubtedly is, and as common as such specimens are (dead from such a cause!) on the plains of New Mexico, I must believe you have quite overlooked the two important points I endeavored to bring out in the paper. The minor point which I invite attention to is, that the specimen exhibits a wonderfully interesting example of that *rare* injury, the result of certain gunshot-wounds known to surgeons as "fracture by *contrecoup*."

But the main object of the memoir is widely removed from this and completely ignored by yourselves. From the data furnished by the Otis "Catalogue of Crania," in the Army Medical Museum, I was enabled to present, for the average male Navajo's skull, the cranial capacity, the facial angle, the length, the zygomatic diameter, etc.; and I further tabulated this information in such a way that it became presentable for comparison. I then carefully compared the skull before me with it, and pointed out how it diverged from the *average* measurements as given in the previous data. The plate illustrates the skull seen from the four principal views, and I take this occasion to thank my engravers for the exceedingly handsome lithograph they succeeded in obtaining from my original drawings. The "Journal of Anatomy" has kindly published for me since a similar paper (illustrated), devoted to a like *comparative* examination of the leading characteristics of the skull among Navajo children.

It stands to reason that to devote a handsome plate and the valuable space in the "Journal of Anatomy" simply to the examination of a *single* Indian skull, however meritorious it might be made, would hardly be tolerated; whereas the *comparative* examination of the data brought out through a study of the characteristics of the different tribes of our North American Indians is a subject which I deem to be one of no little importance. R. W. SHUFELDT.

FORT WINGATE, NEW MEXICO, *November* 27, 1886.

[The confusion of authorship to which attention is called in the above letter, is the result of the substitution of a period where there should have been a comma, after the word "same." Punctuated as it was intended, the list of pamphlets in the heading of the notice will read as belonging primarily to Dr. Shufeldt, as it should read. The rest of the author's criticism is directed to the fact that we omitted to mention the technical bearings of his observations. Technical details are not within the scope of the "Monthly," and the discussion of them would be appreciated by but a small proportion of its readers.—EDITOR.]

BEETLES AS A NUISANCE.

Messrs. Editors:

THAT many insects have decided odors of their own is known to all who have ever taken the slightest interest in that class of the animal kingdom. Some of them are well known to others, even, who take no such interest—to wit, that of the bed-bug (*Cimex lectularius*). Many have a pleasant, musky smell, and others a very intense, disagreeable, or disgusting odor. Among the latter is one of the largest of the American Coleoptera—the *Dynastes tityus* of entomologists. The insect is two inches or more in length, an inch wide, and stout in proportion, of a pale-greenish color, with black spots. In the male the thorax is furnished with a long horn, and with two smaller horns at the base of the large one. On the head is another short, upright, pointed horn, giving the insect a very formidable appearance. This insect has a very strong and lasting odor, comparable to that of tobacco steeped in acetic acid. A single specimen placed in a large room will saturate the atmosphere in a single night, and be perceptible for days thereafter. In the larval state this insect resembles an immense "white grub," in form and structure, but is greenish in color. In this stage it feeds on decaying wood. In the vicinity of Memphis, Tennessee, are thousands of stumps of trees cut some ten years since, and now in just the right stage of decay for this larva. As a consequence, the insect has increased to such an extent as to become literally a nuisance. In the month of June or July an intense disagreeable odor was noticed in some outlying sections of the city, becoming stronger in the evening. The Board of Health took action in the matter, drained a few pools, disinfected other unsavory substances, but produced no effects on the odors. Various speculations were rife in the newspapers as to the cause and effect of the odors, until, finally, a correspondent of the "Memphis Avalanche" solved the mystery by finding large numbers of this insect, which were straightway sent off for determination. Later in the season complaints came from Western Virginia of similar foul smells. Here the health officers made war on the pig-pens, without avail, of course, and here, also, in due season, the source of the smell was discovered in this beetle.

The curious part of the matter is, that this insect has been considered not a common one by entomologists, and now it appears in the light of a pest of a quite novel order, polluting the air so as to become a positive nuisance. Whether the odor is at all injurious to health, I can not say. It will cause squeamishness in sensitive individuals, but it will hardly do more. The remedy is, of course, obvious—remove the stumps, and the source of supply is gone; more than this, the stumps remain in condition for the larvæ for a brief period only, and another year or two will see the end of this peculiar nuisance, unless the supply of stumps or logs is kept up.

John B. Smith.

U. S. Nat'l Museum, Washington, D. C., *September* 9, 1886.

EDITOR'S TABLE.

POLITICAL SKEPTICISM.

AN able writer in the "Revue des Deux Mondes" has lately drawn attention to the extent to which what he calls "political skepticism" prevails to-day in France. He believes that it exists in large measure in other countries as well; but he deals with it principally as affecting his own country. He says that, while men are still divided into parties, there is no longer the earnest belief in definite political principles which was still to be found a generation or two ago. Men no longer adhere to their party through strong conviction or overmastering prejudice; on the contrary, their party is something with which they make terms, and which they expect to find their account in serving. The Conservative is not so very conservative as he used to be, and the Liberal has a greatly diminished faith in liberalism. Nobody expects much from the logical application of any set of principles; the general disposition is to let things drift and wait to see the result.

The condition of things described seems to us the natural effect of two definite causes: first, the operation of the party system; and, second, the practice of looking to the government as the conservator and manager of nearly all important social interests. If anything could undermine political conviction it would be the party system. Its very basis is the sacrifice of individual convictions to party exigencies. It organizes the purchase of political support, and reduces statesmanship to the ignoble level of trickery and clap-trap. We do not need to go to France for an exemplification of its working. Here, in the United States, it has produced all its choicest effects. So bent are our leading politicians upon party and personal success that it is the rarest thing to detect in their public speeches one sincere utterance. The art they most sedulously cultivate is that of hedging on all important practical questions; so that they may be left free to take whatever course the shifting winds of public opinion, or the varying exigencies of personal interest, may require. We do not read their speeches for the purpose of knowing what they think, but for the purpose simply of ascertaining what, at the moment, they consider it safe and politic to say. So thoroughly do certain journals recognize that theoretical convictions have nothing to do with politics, that they scarcely hesitate to erect into a principle that politics should be regarded mainly as a scramble for the offices. One of these the other day expressly and most seriously commended the President for having (as was alleged) appointed a cousin of his wife's to a lucrative consulship, the doctrine laid down being that "to the victors belong the spoils," and that the President did the right thing in providing for his own relatives and friends. Such open cynicism is better, perhaps, than a pharisaical and insincere profession of higher principles; but, with such an illustration of political skepticism at hand, we need not go abroad for instances.

In the second place, the altogether undue reliance placed in these days, upon state action for the promotion of the general welfare tends to produce political skepticism through the disappointment that it is certain to produce. An agency of apparently irresistible force is set in motion, and when it fails to yield the results expected of it, men are apt to conclude that those results are unattainable by any means, and they become discouraged. They forget that the only force the state can dispose of is, in the last resort, physical force, and that physical force may not be what is wanted for the ends in view. The state can make laws, and to a certain extent can enforce them, or, at least, exact penalties for their infraction; but the state can not produce right dispositions in the minds of its citizens. The state can organize schools and assume complete control of education, but it can neither give an integral education, nor can it infuse a right spirit into the system that it administers. It can not do the former, on account of the great diversity of opinions existing throughout the community on various fundamental questions; it can not do the latter, partly because it can not do the former, and partly because political considerations of a low order are constantly intruding into public-school management. The state can undertake great works, but it can not make great men, or make men great; and after it has controlled for a certain length of time of any special sphere of action, we may look there with confidence for conspicuous examples of inertness and incapacity. Another evil is that the vast apparent power of the state leads to the cherishing of extravagant hopes and expectations. Men would not expect great reforms in a year or two if they did not count on legislation doing wonders for them. In spite of multiplied proofs to the contrary, they think that, if they can only get a law passed, all the rest will follow of itself. And so, as in the State of Maine, they get a law passed, and then spend forty years in tinkering at it, in the vain effort to find out why it won't work, or why it works in a direction opposite to what they intended.

The remedies, therefore, for political skepticism are obvious. Let us, in the first place, abate the excesses of the party system, and for the future, instead of striving to keep all great public questions "out of politics," let us try to get them into politics; and then let us deal with them with an eye to the greatest good of the nation at large. No doubt there will be differences of opinion as to what is best to do; but, the more there is of honest conviction on such questions, the less there will be of "political skepticism." The mere conflict of opinions will never produce civil discord; it is when theories, in the strict sense, are flung aside, and *interests* confront one another in battle array, that real danger arises. The question is simply, Shall we or shall we not consult together like loyal citizens for the good of the state? If we determine to do so, we raise politics at once to the level of as noble and honorable a pursuit as any man can engage in. Our object, then, is truth in its application to national affairs, and politics becomes a branch of science. If, on the other hand, we can not, as citizens, summon up enough disinterestedness to think and labor for the general good, but allow ourselves to be marshaled into parties fighting for no determinate object save the spoils of office or the vain satisfaction of a party triumph, then, truly, the reign of political skepticism must ever become more absolute, and the country be brought yearly nearer to the edge of a dangerous convulsion.

We think there are signs of an awakening of the public mind to the evils of the party system; but something more is wanted for a true political equilibrium than the mere cessation of unmeaning party strife. We need to come down to more moderate views of what state action can reasonably be expected to effect. We need a truer perception of the methods by which, and the rate at which, great social reforms are accomplished. We need to repeat to ourselves continually that might does not make right, and that the might of a majority may be as fatally in the wrong as the might of an individual. Before invoking the power of the state, we should ask ourselves whether the case is one in which the power of the state *ought* to be exerted. The doctrine is now all but officially promulgated, that majorities can not possibly do wrong, and therefore that the power possessed by a majority may at any moment be rightly employed to enforce its will. This is political skepticism with a vengeance, substituting, as it does, the ballot-box for the moral law. The notion is one that we must unlearn, as we value our integrity as a people; for no community can long prosper that has once enthroned force in the place of justice. It is impossible to develop fully within the limits of an article like the present the idea here outlined, but we are convinced that many of the most discouraging characteristics of the present day, including the "political skepticism" above specially referred to, are in great part traceable to the growing habit of looking to the state to do things which, if done at all, should be done by private effort and the growth of opinion.

A WONDERFUL ARGUMENT.

We find in "The Varsity," a weekly journal published at Toronto, Ontario, in the interest of Toronto University, a wonderful argument for the perpetual retention of the present arbitrary rules of English spelling. "It is a saddening reflection," says our contemporary, "that there should be men, our brothers, whose limbs should be stiffened by day-long labor of the body, and into whose minds no light shines through their lives; but the desire to utterly obliterate whatever may in any way serve to distinguish the man of culture from his illiterate brother must be looked on in no other light than as one of the many manifestations of that misty socialism which is clouding so many minds to-day." Here is intellectual snobbery with a vengeance. Forsooth, we must keep up a difficult and arbitrary mode of spelling in order that the poor man may spell badly, and so be distinguished from the man of culture! When we first began to read about those unhappy men, "our brothers," whose limbs were stiffened by toil, and whose lives were so destitute of light, we thought the editor of "The Varsity" was about to come forward with some chivalrous scheme for diminishing their burdens and helping the light to penetrate into the dark places. But, no; his cry is, "Keep them down! They can never learn to spell English according to the present rules; so let us see to it that we, the nurslings of culture, the children of light, resist all attempts to introduce any simpler, even though more scientific and more philological, system of spelling. Otherwise what will there be to distinguish us intellectually from those poor, toil-stiffened creatures?" One is tempted to say in reply that, if superiority in the matter of spelling is *needed* to distinguish men of culture from men destitute of culture, then culture itself must be a very poor and unsubstantial thing. Imagine, for a moment, two men, one of whom has had a university education, while the other has lived such a life of bodily toil that no light has shone into his mind; and then imagine, further, the gentleman of the first part asking that spelling may be kept a difficult and mysterious art, in order that there may be something to distinguish him from his *illiterate* brother, whose condition, however, he hastens to say, excites his profound sympathy! The thing is most ridiculous; but, in so far as it may be held to indicate the spirit in which university journals are conducted, it has its serious and lamentable side. A university sustained by public moneys should have as its one great object the rendering of service to the community as a whole. If it can only train a limited class, that class should look upon themselves as trustees for the whole people of the superior advantages their education confers upon them. Why should public money be spent in making A. B. a particularly intelligent and accomplished man, if he is going to put on fine intellectual airs, and even ask for special protection against the unlettered multitude? In this matter we have not yet got down to "hard pan," but we must get down to it. We are no advocates of a "misty socialism"; but we do not only advocate but demand the strict and scrupulous appropriation of public moneys to public purposes in the very widest sense of the term. To establish a system of intellectual caste is not a public purpose nor a social purpose, but an anti-social one. Let men who want to strut in intellectual broadcloth find their finery for themselves; but when a great educational institution has been established by the aid of public funds, let those who avail themselves of its advantages recognize that they are called to a ministry of public usefulness, and that it is theirs to see that, in some way, the toiling classes get a share of the benefits provided. Never shall we have a society worthy of the name, until those who have—whether in a material or an intellectual sense—are actuated by a sense of duty toward those who have not. When that day comes, we shall not hear it urged, as an argument for the retention of a difficult system of spelling, that it serves as a convenient mode of distinguishing the cultured from the uncultured classes. In that day, too, culture will probably mean something more than the ability to spell. It will be a thing of ideas and of real knowledge, a thing expansive by nature, and in the best sense of the word democratic. We should strongly advise the universities of to-day to prepare for the new culture of the future, and meantime to do their best to purge themselves thoroughly of that spirit of exclusiveness so plainly manifested in the passage quoted from "The Varsity," and of which it probably would not be difficult to gleam examples in other similar quarters.

LITERARY NOTICES.

Johns Hopkins University Studies from the Biological Laboratory. Edited by Professors Newell Martin and W. K. Brooks. Vol. III. Baltimore, Md.: N. Murray, publisher.

When a former volume of this publication was reviewed in these pages, we commended the intelligence and liberality of the trustees for recognizing the importance of supporting a scientific publication of so special a character as this one. It is an encouraging omen for science in this country, that universities are recognizing the importance of publishing the results of their laboratory-work. Aside from the honor which an institution derives from an issue of this nature, there is good reason to believe that such a publication is a proper investment for a library fund. Every college library needs upon its shelves the journals and transactions of home and foreign societies. Instead, then, of subscribing for many of these, it were better to invest the same amount in a publication which, by judicious exchange, accomplishes the same result, with the added satisfaction of contributing its scientific work to the world. The numbers before us maintain the high standard of the previous volumes. Space will permit hardly more than a mention by title. The volume commences with a memoir entitled "Significance of the Larval Skin of Decapods," by H. W. Conn. The author states that crustacea are a particularly favorable group for the study of phylogeny, and then proceeds to show the significance of the larval skin, and a very interesting discussion is given as to the ancestral form of crustacea. From his study of the larval cuticle in the long- and short-tailed decapods, the author infers that "all decapods are to be referred back to a form similar to the *protozoœ* (zoea), in which the segments of the thorax and probably of the abdomen were present, and whose antennæ were locomotive organs." Mr. Conn has another paper on the "Life History of Thalassema," a peculiar worm which lives within the empty shell of mellita or "sand dollar." He finds, among other interesting conditions, "the origin of the ova and spermatozoa as modified peritoneal cells, their growth in the body cavity, and their preservation in a sexually mature condition in sexual pouches. A segmentation of the embryo which is exceptionally among annelids perfectly regular, and the origin of the ventral nerve-cord from the ectoderm as a bilateral structure." Henry Leslie Osborn gives the results of his studies on the gill in some forms of prosobranchiate mollusca. Professor Lankester, in his valuable paper on mollusca, in the last edition of the "Encyclopædia Britannica," states his belief that the primitive gill of the mollusca was a *ctenidium*, a stalk with plates very much like the gill of Chiton and Fissurella. Mr. Osborn is led, however, from his embryological studies, to question this view, and to doubt whether the ctenidium form represents the primitive form of molluscan gill, and shows that in the *ctenobranchs* the gill is not a ctenidium, but a very much simpler organ. Its form compares closely with the primitive lamellibranchiate gill.

"Notes on the Composition of the Blood and Lymph of the Slider Terrapin," and also "On the Origin of the Fibrin formed in the Coagulation of Blood," by W. H. Howell. Both these memoirs are too technical for a short review.

"On the Action of Acid, Atropia, and Convallaria on the Heart; with some Observations on the Influence of Oxygenated and Non-Oxygenated Blood, and Blood in Various Degrees of Dilution," by H. G. Beyer. The title sufficiently indicates the scope of this paper, which will be more interesting to students of therapeutics, and to these and to physicians we commend it.

"The Action of Intermittent Pressure and of Defibrinated Blood upon the Blood-Vessels of the Frog and Terrapin," by Louis T. Stevens and Frederic S. Lee. This paper, like the last, is mentioned by title and for the same reason.

"Cranial Muscles of *Amia calva*, with a Consideration of the Relations of the Post-Occipital and Hypoglossal Nerves in the Various Vertebrate Groups," by J. Playfair McMurrich. His investigations lead him to believe that the primitive *Elasmobranchs*, the *Ganoids*, and the *Teleostei*, to be connected along one line, and the *Cyclostoma*, *Dipnoi*, and *Amphibia* along another.

"On the Endings of the Motor Nerves in the Voluntary Muscles of the Frog," by Chr.

Sihler, M. D. In this memoir is described a new method of demonstrating the nerve-endings in the muscles of the frog, as well as to bring forth evidence supporting the view that the terminal nerve-fibers are situated on the outside of the *sarcolemma*, and do not, as taught by most authorities, penetrate this envelope."

"Marine Larvæ and their Relation to Adults," by H. W. Conn, is an interesting memoir on the relations of various large groups of animals, based on the larval stages of these groups. Based on these relations solely, the author would place in the first group *Cœlenterata*, *Polyzoa*, and *Brachiopoda;* in another group the *Mollusks* and *Annelids*, and probably the *Planariane;* while a third group would contain *Echinoderms*, *Balanoglossus*, and probably the nemerteans and vertebrates. As the sponges and arthropods show no approach to the pilidium larva, they are not considered. Possibly this novel classification might be completed by uniting these in a fourth group! The volume closes with a paper by William Trelease, entitled "Observations on Several Zoögloeæ and Related Forms." This paper deals with bacteria, micrococcus, and related forms, with determinations of new species.

We may add that these papers are highly technical, and are accompanied with excellent plates.

Numbers Applied. A Complete Arithmetic. By Andrew J. Rickoff. New York: D. Appleton & Co. Pp. 416. Price, 75 cents.

This work has been prepared to meet the wide-spread and growing demand for a treatise on arithmetic adapted to the objective methods of instruction now common in schools. In its preparation the author has kept in view the thought that words are useless in the measure that they fail to call up in the mind vivid images of the things signified; and that, to the learner, the operations of arithmetic are apt to be only manipulations of figures after prescribed models, unless he realizes the fact that they are representatives of processes that may be applied to material objects. Hence the attempt has been made to vitalize the relation of words and things by the aid of the best practicable illustrations at every point; and to bring forward problems, or examples for solution, that should have life in them, or bear some relation to the affairs of every-day life. The work has been adapted, as far as possible, to the needs of those children who are liable to be withdrawn from school before a full course in arithmetic can be completed. Hence, the more useful business applications of elementary principles are made as soon as they are learned. Thus, familiar measures are introduced before reduction is mentioned; federal money before decimals; many practical measurements before mensuration; and questions even in percentage and interest are met with before those subjects are reached in due course. The conditions of these problems are so presented as to be within the easy understanding of the pupil, while their solution requires only such arithmetical operations as he has already learned. The authors also call attention to the simple treatment of the decimal system of notation and the variety of exercises under it; to the multiplicity of short exercises, while longer ones are not wanting; to the directions to the pupil, having in view the formation of right habits of computation; to the suggestions for original problems; to the simple and direct methods of treating the various subjects; and to the rigorous adherence to the inductive methods of instruction.

The Irish Question. By the Right Hon. W. E. Gladstone. New York: Charles Scribner's Sons. Pp. 57. Price, 10 cents.

In this pamphlet Mr. Gladstone explains and vindicates the position on the Irish question which he assumed and maintained while he continued in office as the working head of the British Government. The discussion is divided into two parts, with papers under the headings, "History of an Idea" (the Irish idea of home-rule), and "Lessons of the Election." The "Lessons" are for the Liberal party and for Ireland, and relate to the purchase and sale of land, and the conservatism of home-rule. In the conclusion, Ireland is advised to walk to the consummation of her wishes in the path of constitutional and peaceful action, and of steady, free, and full discussion, which has led England and Scotland to triumph.

The Life of Robert Fulton, and the History of Steam Navigation. New York: G. W. Putnam's Sons. Pp. 507. Price, $1.75.

In this book a great deal of information of an interesting character is packed into a moderate space; and the packing has been well done. Fulton's life is itself full of incident and adventure, illustrating the strong bent of his genius toward a particular line of experiment, and the persistency with which he kept his attention fixed on carrying the objects he had in view to a successful result. The materials for the life have been drawn from many sources, and his career as a whole is presented in an attractive light, and in its main features as an example of well-directed effort. The life of Fulton serves as an introduction, but an important one, to the history of steam navigation, which is very comprehensive. Beginning with Fulton's earliest experiments, as related in the "Life," it traces the history of the Hudson River steamboats, of steamboat navigation on the Mississippi and Ohio, the Great Lakes, Long Island Sound, English, and other foreign waters, from the earliest efforts of each down to the present time; relates the histories, severally, of the various great lines of steamers that have sailed or are now sailing on the ocean between the ports of the different continents, and closes with notices of war-steamers and ironclads. The illustrations represent numerous steamers and parts of steamers, beginning with Jonathan Hill's tow-boat in 1736, and ending with such vessels as the City of Peking, the Pilgrim, and the Alaska.

General Biology. By William T. Sedgwick, Ph. D., and Edmund B. Wilson, Ph. D. Part I. Introductory. New York: Henry Holt & Co. Pp. 193.

The authors of this book acknowledge that it owes its origin to the influence of Huxley and Martin, authors of the "Elementary Biology." Their aim has been, not to prepare an exhaustive treatise, but rather to lead beginners in biology from familiar facts to a better knowledge of how living things are built and how they act, such as may rightly take a place in general education, or may afford a basis for further studies in particular branches. "It is still an open question," they say, "whether the beginner should pursue the logical, but difficult course of working upward from the simple to the complex, or adopt the easier and more practical method of working downward from familiar higher forms. Every teacher of the subject knows how great are the practical difficulties besetting the novice, who, provided for the first time with a compound microscope, is confronted with yeast, protococcus, or amœba; and, on the other hand, how hard it is to sift out what is general and essential from the heterogeneous details of a mammal or flowering plant. In the hope of lessening the practical difficulties of the logical method, we venture to submit a course of preliminary study, which we have used for some time with our own classes, and have found practical and effective. Believing that biology should follow the example of physics and chemistry in discussing at the outset the fundamental properties of matter and energy, we have devoted the first four chapters to an elementary account of living matter and vital energy. In the six chapters which follow, these facts are applied to a fairly exhaustive study of a representative plant and animal, of considerable though not extreme complexity." The fern is selected as the plant, and the earth-worm as the animal. The last chapter comprises a brief account of the principles and outlines of classification as a guide in subsequent studies. From this the pupil may pass to other books, or to the second part of this one, which is to be published in the course of the following year.

The Menorah. A Monthly Magazine. Edited by Benjamin F. Peixotto. Vol. I, No. 2. Pp. 48. Price, 25 cents; $2 a year.

"The Menorah" is the organ of the Order of the B'ne B'rith, which was established in 1843, to provide a bond of philanthropic and patriotic feeling among persons of the Hebrew race in the United States, and which has now more than four hundred lodges and nearly thirty thousand members. It contains a variety of literary articles, including a history of the order, to most of which a peculiar Jewish interest is attached; is divided into an English and a German part; and has departments devoted to Hebrew affairs at large, and to the order which it represents. We learn from it that the Maimonides Library contains 26,840 volumes, the annual circulation of which is 47,570 among 4,708 readers. Of the additions of the past year only twenty-eight per cent were fiction. The librarian, Mr. Max Cohen, is collecting for it a body of works on political and social science; and efforts are making to secure an educational collection, for which books on the methods of instruction and administration of schools in this country and Europe have been acquired.

The Philosophy of Education. By Johann Karl Friedrich Rosenkranz. Translated from the German by Anna C. Brackett. Second edition, revised, with Commentary and Analysis. New York: D. Appleton & Co. Pp. 286. Price, $1.50.

This is the first volume of the "International Education Series," to be published by D. Appleton & Co., of which Dr. W. T. Harris is the editor. The original translation, which was made for the "Journal of Speculative Philosophy," was intended for the use of philosophical students, who in general admire precise technical terms. In preparing the present edition, the translation has been revised with a view better to adapt it to the needs of translators not skilled in philosophy. Where it has been thought necessary, phrases, or even entire sentences, have been used to convey the sense of a single word of the original; so that the editor is able to claim that no obscurity remains except such as is due to the philosophic depth and generality of the treatment, and that the translation is now more intelligible than the original. The peculiar merit of Rosenkranz's work is found in the fact that in it everything is brought to the test of the highest principle of philosophy; that one which is the acknowledged principle of Christian civilization, and which, as such, the author makes the foundation of his theory of education, while he demonstrates its validity by an appeal to psychology on the one hand, and to the history of civilization on the other; the principle of promoting the elevation of the human race. Among the points of great value, the author directs attention to the principle of self-estrangement as lying at the foundation of the philosophy of education, and as furnishing a key to many problems discussed by the educational reformers from Comenius to Herbert Spencer. The distinction of corrective and retributive punishment, the part of the work devoted to educational psychology, the methods of treating the three grades of capacity—the blockhead, the mediocre talent, and the genius—the care with which the subject of morality is treated, and the clearness with which the importance and functions of religious education are set forth, are particularly commended. An entire division of the book is taken up with a history of education, based on the philosophy of history. It is rather an outline of the history of human culture than a special history of schools or of pedagogics, and is recommended as highly valuable for teachers and parents, and for all who desire to see in a condensed form the essential outcome of human history.

Topographical Drawing and Sketching, including Applications of Photography. By Lieutenant Henry A. Reed, U. S. Army. New York: John Wiley & Sons. Pp. 129, with Twenty-four Plates. Price, $3.50.

The amount of literature which is devoted exclusively to the subject of topographical drawing and sketching, as distinguished from the actual field-practice, is very scarce. When the surveyor has completed the collecting of all the data which are necessary for the obtaining of an exact reproduction on paper of the area which has been surveyed, the question arises, Which are the best methods by which these data can be graphically reproduced in a map, so as to give the reader the best possible idea about the exact formation of the ground surveyed, whether it be a farm, a county, or a State? The progress made in topographical drawing has been very great, and although, of course, many conventional signs and colors have to be used, these are such that even unpracticed eyes may be able to read a map and to understand it in its minutest particulars.

Lieutenant Reed is Assistant Professor of Drawing at the West Point Military Academy. In his preface he states: "The writing of this book was first suggested by the fact that there was no native work which fully treated of and illustrated rapid methods of hill-shading, and it is now written not only to explain these and other methods now used, either separately or in conjunction with them, but also to present the subject of topographical sketching in a form suited to a beginner."

The book is divided into two chief parts, topographical drawing and topographical sketching. The first is the exact reproduction, while the second is a more ready and quick, although not so exact, reproduction of the ground. The twenty-four plates form a very complete collection of all the instruments used by the surveyor and the draughtsman; they are very valuable, and contain, besides examples of work, conventional signs, hill-shading as executed on maps in this country and abroad, conventional tints, and projections for maps of large areas. The first nineteen plates are devoted to drawing, while the other five illustrate the instruments and methods used in sketching. Although sketching is not so exact and accurate as topographical drawing, it is, nevertheless, in many cases desirable to have the sketches as accurate as it is possible to obtain them. All the resources of modern science are called to help to assist in obtaining this desired result. Among these, photography also plays a not unimportant part.

It would be difficult to say whether the text has been written to explain the plates, or whether these have been made in order to illustrate the text. The two are so necessary to each other that they could not be separated.

Lieutenant Reed's work can not fail to recommend itself both to the beginner and to the veteran topographer. Even those whose special study is not in this line, will find it interesting in more than one respect.

Fourteenth Report of the Commissioners of Fisheries of the State of New York. Albany: Weed, Parsons & Co. Pp. 209.

In accordance with the spirit of the legislative act under which the commission was instituted, hatching-stations have been established on the Hudson River for shad; at Caledonia, Livingston County, for the propagation, principally, of the trout kind—with a source of supply at Rochester for black bass, perch, pike, banded perch, and bull-head; at Cold Spring Harbor for anadromous fish, trout, and sea-fish; at Lake Brandon, Franklin County (Adirondack hatchery), for fish of the trout kind; and at Clayton, Jefferson County, for salmon, trout, white-fish, rainbow-trout, and perch-pike. The total production from 1870 to 1886, at the two stations in full operation (Caledonia and Cold Spring Harbor), was 102,549,624 of all kinds. The details of operations at the several stations, minutes of the proceedings of the Board of Commissioners, and the reports of game and fish protectors and protection societies, are given in the report.

The Age of Electricity. From Amber-Soul to Telephone. By Park Benjamin, Ph. D. New York: Charles Scribner's Sons. Price, $2.

The chief wonders of the modern world are the marvelous applications of electricity which have recently appeared in quick succession. To those who would have an intelligent knowledge of what has been done in this field, and would understand, in some measure, how it has been arrived at, this book is addressed. It is a book to be read rather than one to be studied, although, in a work describing any of the peculiar manifestations of electricity there must be passages which require the reader's close attention, unless he is content to pass them by. Not many pages are needed for sketching the electrical discoveries made before 1820, of which the most important were galvanism, and Franklin's demonstration that electricity and the lightning are identical. The author then takes up the chief topics of his subject singly, describing, in successive chapters, the galvanic battery, the electro-magnet, the dynamo-electric machine, the electric light, electro-motors for land, water, and aërial use, electro-deposition of metals, and the storage-battery, the telegraph, including multiple and autographic telegraphy, the telephone, and the induction-coil, closing with a chapter on applications of electricity to the arts of war, railroading, medicine, dentistry, music, domestic economy, etc. In the chapter on the telephone, are described the microphone and the phonograph; also the instrument which embodies the latest and most wonderful mode of transmitting messages—the photophone. The author has avoided technicalities, and has left out descriptious of complex instruments and operations which he deemed more likely to weary than to interest the reader. In dealing with the conflicting claims of rival inventors, he has endeavored to present the leading attainable facts without partisan bias. For the most part, historical data have been gathered from publications contemporary with the date of first production of the several discoveries and inventions, and, in many cases, from the original writings of the inventors and discoverers themselves. The text is illustrated with 143 figures, and the pages are freshened here and there by anecdotes and scientific poetry.

Elements of Geodesy. By J. Howard Gore, B. S. New York: John Wiley & Sons. Pp. 282.

Among the exact sciences geodesy is the one most specially devoted to ascertaining what are the exact form and dimensions of the earth. In the book under review no new theories are advanced, none of the questions requiring solution are discussed. The author, who is Professor of Mathematics in the Columbian University, has endeavored to give in a concise and readable manner all that the student ought to be acquainted with. As he himself states in his preface: "The advanced student and practiced observer will find nothing new in this work." And also: "It is hoped that the beginner will be enabled to get a clear insight into the subject, and feel grateful that the discoveries and writings of many have been so condensed or elaborated as to make the study of geodesy pleasant."

The first chapter, which is an historic sketch of geodetic operations, is interesting and full of facts tending to show what progress has been made from the earliest times, and how the desire to know the real dimensions of the earth has kept man busy in devising and perfecting the methods of measurement. The progress made is given step by step, and, as no intricate mathematical questions are mentioned, this chapter can be read with profit by even those who are absolutely profane in mathematical studies.

Other chapters treat of instruments and methods of observation; base-measurements; field-work; the theory of the least squares; the calculations of the triangulation; formulæ for the computation of geodetic latitudes, longitudes, and azimuths; calculation of the figure of the earth. The dimensions obtained by some observers are given, as follows: Equatorial radius: Bessel (1841), 6,337,397·2 metres; Clarke (1866), 6,378,-206·4 metres; Coast Survey (1877), 6,378,-054·3 metres; Clarke (1880), 6,378,248·5 metres. Length of the quadrant: Bessel (1841), 10,000,856 metres; Clarke (1866), 10,001,888 metres; Clarke (1880), 10,001,-869 metres. Over twenty pages of formulas and factors are added at the close which will be useful for easy reference. Although this work is intended for students, practiced observers will find it a useful addition to their shelves.

History of the Land Question in the United States. By Shosuke Sato. Baltimore: N. Murray. Pp. 181. Price, $1.

This volume constitutes three numbers of the Johns Hopkins University "Studies in Historical and Political Science." It was undertaken by the author in pursuance of special instructions from the Japanese Government to investigate certain questions of agrarian and economic interest in the United States. In the introduction are considered the general questions relating to the origin and importance of the public domain and to the principles of land-tenure. The story of the formation of the public domain is then told, its acquisition being the result of cessions by the States, the purchases of Louisiana and the Floridas, Texas annexation and Texas cession, the Mexican cessions, and the purchase of Alaska. Under the heading of "The Administration of the Public Domain" are related the histories of the Ordinance of 1787 and of the General Land-Office. Finally, the "History and Present Condition of the Land System of the United States" are surveyed in detail.

The American Citizen's Manual. By Worthington C. Ford. Two volumes in one. New York: G. P. Putnam's Sons. Pp. 331. $1.25.

The two books, or rather the two parts of the same book, here combined into one volume, have been before the public for several years, and have been generally commended as carefully prepared and useful manuals of instruction in the rights and duties of citizenship. Their purpose is to answer the continually recurring question, What is the relation of the citizen of the United States to the governments under which he lives? The first step in giving the answer is to gain some knowledge of the machinery of government, its organization and manner of acting; together with the methods of choosing the agents of State action, and the more important points regarding official responsibility and the civil service. These subjects are treated of in the first part of the book, the original first volume. In the second part are considered the governmental duties of protection to life and property, the particular functions of the Federal and State governments, and questions of State finances.

History of the Appointing Power of the President. By Lucy M. Salmon. New York: G. P. Putnam's Sons. Pp. 129. Price, $1.

This is one of the papers that were read at the meeting of the American Historical Association at Saratoga in September, 1885. It considers the subject of the appointing power of the President as presented in four periods: First, in the theoretical stage, 1787–1789, or the question in the Philadelphia Convention and the first Congress; second, in the period from 1789 to 1829, or, as exercised by statesmen, both Federalist and anti-Federalist; third, in the spoils period, 1829–1861, including President Jackson's interpretation of the Constitution and the results of that interpretation; and, fourth, in the reform period, including the culmination of the spoils system and the attempts to check the evil. In conclusion, though the last period has indeed been one of reform, though a practical civil-service bill has been passed, political assessments done away, and a temporary check given to the "courtesy of the Senate," yet after all it has been but an entering wedge. "The four years' limitation law is still on the statute-books; the Pendleton bill applies to only one seventh of our civil officers, and can be broken in spirit if not in letter; our consular service is still a refuge for those who desire to travel abroad at Government expense; foreign courts have rebuked our diplomatic system by refusing to accept representatives appointed for other reasons than that of fitness for place; 'offensive partisanship,' when other pretexts fail, can be made to cover a multitude of removals; in our State and local administrations scarcely an attempt at reform has been made. A fourth [fifth] period in the history of the appointing power is to come—a reformed period; when the chief Executive can boast like the great Premier that his sole patronage is the appointment of his private secretary; when every legislator can say, with a leading member of the House of Commons, that he is without power to influence in the smallest degree the appointment of a custom-house officer or an exciseman; when both Executive and Congress, freed from their duties of dispensing office, can turn their attention to more important questions of state; when our civil service will be in reality, and not in the idle jest of a politician, 'the best in the world.'"

First Steps in Scientific Knowledge. By Paul Bert. Translation by Madame Paul Bert. Revised and corrected by William H. Greene, D. D. Philadelphia: J. B. Lippincott Company. Pp. about 400. Price, 60 cents.

The author of this manual was one of the most eminent scientific men in France, and for some years filled the post of Minister of Public Instruction under the republic. If we recollect aright our reading of the French scientific journals of the time, he took particular delight in the preparation of the primers embodied in the volume, in simplifying science, and making it attractive to the children over whose educational interests he was engaged to watch. The "First Steps" are based on the principles of object-lessons. They are prepared so that they may be taught experimentally by skilled teachers, or with the aid of the objects themselves; or, if that is not convenient, abundant illustrations are furnished, through which the most important facts are exemplified by accurate pictures. The work is complete in seven parts, which are devoted respectively to animals, plants, stones and rocks, physics, chemistry, animal physiology, and vegetable physiology. The American editor has made only such changes and additions in Madame Bert's translation as were necessary to Americanize the book, and adapt it to the requirements of public and private schools, as well as to home instruction in this country.

Report upon the Third International Geographical Congress and Exhibition at Venice, Italy, 1881. By Captain George M. Wheeler. Washington: Government Printing-Office. Pp. 586, with Eleven Maps and Plates.

The report embraces an account of the proceedings of the Congress and a description of the Exhibition, in which the more important nations of the world showed the results of the best work that had been done in them in geography, topography, and cartography. More than this, it draws the lessons from those results of what may be of most benefit to the United States and to individual States. Of this character is the information it contains respecting the origin, functions, history, and progress of the several governmental topographic, hydrographic, and geologic surveys. The reports on Government land and marine surveys are full, and represent twenty-five countries. Under the head of works of reference are given copious bibliographies of English, French, German, Italian, Danish, and Spanish topographic surveys, Portuguese reports, and general geologic reports. The chapter on methods of reproduction (of maps), in which the various processes are described, is supplemented by plates giving specimens of the best maps executed in Switzerland, Germany, Spain, Saxony, Java, and France, illustrating as many methods of representation, each of which has its peculiar excellences. The author was a regularly appointed commissioner of the United States to the Congress and Exhibition, and had liberal facilities afforded him for collecting information. He hopes that what he has presented here may throw some light on the extent and object of the great land and water surveys of the world, and that it may form the basis of further researches in the direction outlined.

Sechrist's Hand-Book and Railway Equipment and Mileage Guide Monthly. S. P. Sechrist, Editor. Cleveland, Ohio: J. B. Savage. Pp. 190.

This publication is designed particularly for the use of operating railroad men. It contains tables of the passenger and freight equipment of all (American) railroads, giving numbers of cars, dimensions, capacity, etc.; works and equipment of all freight-lines and private car companies; official information showing to whom car-traces should be addressed, report of car-service made, and remittances for car-mileage sent; and other information of similar character; together with lists of railroad officers and offices, connections and junctions. It is the official guide of the Car-Accountants' Association of the United States and Canada.

Brachiopoda and Lamellibranchiata of the Raritan Clays and Greensand Marls of New Jersey. By Robert P. Whitfield. Washington: Government Printing-Office. Pp. 269, with Thirty-five Plates.

This monograph was prepared for the Geological Survey of New Jersey, and is published in the series of the "Geological Survey of the United States." While the district from which the fossils described come is a limited one, it is one which, according to Professor George H. Cook, drew the attention of paleontologists earlier, and has been studied longer, "so that it is classic and typical ground for all American geologists." The boundaries of the district and its general features are carefully defined and described by Professor Cook in a preliminary note and in an accompanying map. Professor Cook also commends the author's work in bringing the fossils together and in revising and collecting imperfect descriptions, and in making new and better drawings; while the new species he has been able to add give completeness to the subject. Heretofore, many of these fossils which were described were not figured, and the descriptions were scattered in so many different works that they were practically inaccessible to most persons. Professor Whitfield has aimed to include in his report all the species of the two orders of the greensand marls and clays hitherto described and published, as well as several now made known for the first time. "It will be noticed," he observes, "that very few of the species have been recognized from localities outside of the State. It is certainly peculiar that so many local species should have existed within the limits of New Jersey. This may, however, be attributed to certain causes which have existed over these areas during the deposition of these formations, and which would have produced a special fauna fitted for those conditions by eliminating from it all other forms not fitted to withstand them. Beyond this certain rapid or sudden changes seem to have taken place over nearly the entire coast of the State, at somewhat regular periods, which materially changed the conditions of life abruptly." The condition of preservation of the fossils, which are generally seen only as internal casts, also makes them hard to identify with perfect shells.

Proceedings of the American Society for Psychical Research. Vol. I, No. 2. Boston: Cupples, Upham & Co.

This association appears to be making progress. The present number of its proceedings contains an interesting address from the president, Professor Simon Newcomb, of Washington, D. C., which discusses the subject of thought-transference with acumen indeed, but with only negative results; a report on the number-habit as bearing on thought-transference; a report of the committees on hypnotism, on mediumistic phenomena, and on thought-transference, with an appendix containing some experiments in the last-named field; a paper on the existence of a magnetic sense; a research on the reality of Reichenbach's flames; a preliminary report of the committee on apparitions and haunted houses, and a schedule of directions for investigation as to the alleged facts respecting the same. The society is now getting into good working order, and ought soon to give us something tangible as the fruit of its labors.

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Kedzie, R. C. Agricultural College of Michigan. Analysis of Commercial Fertilizers. Pp. 7.

Rigg, James, London. Catalogue of Apparatus for Technical Instruction, etc. Pp. 80.

Holden, Edward S. Photography the Servant of Astronomy. Pp. 12.

J. & J. Cash. Coventry, England, and New York. Harvard Commemoration Badge, satin.

Martin H. Newell, and Brooks, W. K. Studies from the Biological Laboratory of Johns Hopkins University. Vol. III. No. 8. Baltimore: N. Murray. Pp. 80, with Plates. $1 and $5 a volume.

Powter, N. B. Grand Caymans "Natural Phosphatic Guano." New York: Leaycraft & Co. Pp. 20.

James, Professor Joseph F., Oxford, O. Topography of Cincinnati. Pp 6.

Union for the Improvement of the Canals of the State of New York. Proceedings of the Second Annual Convention. Pp. 15.

Wilder, Burt G. The Collocation of a Suture and Fissure in the Human Fœtus. pp. 6. Human Cerebral Fissures, etc., pp. 4. The Paroccipital Fissure, pp. 4. Notes on the Brain, and other Papers, pp. (in all) 7.

Hunter, Osborne, Jr., Washington, D. C. Labor *versus* Capital, etc. Pp. 32.

Ashby, Thomas A., M. D. On Operating during the Same Anæsthetization for Lacerations of the Cervix Uteri and Ruptured Peritonæum. Baltimore: Medical Journal. Pp. 10.

Becker, George F. The Washoe Rocks. Pp. 28.

Massachusetts State Agricultural Experiment Station. October Bulletin. Pp. 12.

Griswold, W. M. The Continuous Index. October and November, 1886. Pp. 1. 25 cents a year.

Williams, Chauncey P. Gold, Silver, and the Coinage of the Silver Dollar. Albany: Weed, Parsons & Co. Pp. 26.

Shufeldt, R. W. On an Old Portrait of Audubon, etc. Pp. 4, with Plate.

Crothers, T. D., M. D., Hartford, Conn. Certain Hereditary and Psychical Phenomena in Inebriety. Pp. 15.

Cornell University. Proceedings in Memory of Louis Agassiz, and in Honor of Hiram Sibley. 1885. Pp. 88.

Newberry, J. S. Earthquakes. Pp. 19.

Martin, Lillie J. Outline for Study in Chemical Botany, pp. 3. Plan for Laboratory Work in Chemical Botany, pp. 3. Preliminary Analysis of the Leaves of Juglans Nigra, pp. 7.

Brinton, Daniel G., M. D. Ikonomatic Writing. Pp. 14.

Dawson, Sir J. William. The Geological History of the North Atlantic. Montreal: Gazette Company. Pp. 50.

Rauch, John H., M. D., of Illinois. Address in State Medicine. Pp. 28.

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State Board of Health of Illinois. Eighth Annual Report. Springfield, Ill.: H. W. Rokker. Pp. 556. Medical Education and Medical Colleges in the United States and Canada. 1765–1886. Pp. 172.

P. Blakiston, Son & Co., Philadelphia. The Physician's Visiting List for 1887. Twenty-five patients weekly. $1.

Ives, Frederick E., Philadelphia. Isochromatic Photography with Chlorophyll. Pp. about 50, with Plates.

Peale, Albert C., M. D. Mineral Springs of the United States. Washington: Government Printing-Office. Pp. 225.

Raleigh, Thomas. Elementary Politics. London: Henry Frowde. Pp. 163. 25 cents.

Publishers' Weekly. Illustrated Christmas Number. 1886. Pp. about 200.

Mills, T. Wesley. Outlines of Lectures on Physiology. Montreal: W. Drysdale & Co. Pp. 200. $1.

Clifford, William Kingdon. Lectures and Essays. London and New York: Macmillan & Co. Pp. 441. $2.50.

Jukes-Browne, A. J. The Student's Hand-Book of Historical Geology. New York: Scribner & Welford. Pp. 597.

Colter, Buel P. An Elementary Course in Practical Zoölogy. Boston: D. C. Heath & Co. Pp. 189. 85 cents.

Mallock, W. H. The Old Order changes. New York: G. P. Putnam's Sons. Pp. 513. $1.

Randall, Rev. D. A. Ham-Mishkan, the Wonderful Tent. Cincinnati: Robert Clarke & Co. Pp. 420. $2.

Stephens, H. Morse. A History of the French Revolution. Vol. I. New York: Charles Scribner's Sons. Pp. 533. $2.50.

Tyrrell, Gerard G., M. D., Secretary, Sacramento, Cal. Ninth Biennial Report of the State Board of Health of California. Pp. 282.

Burnham, S. M. Precious Stones in Nature, Art, and Literature. Boston: Bradlee Whiddin. Pp. 400, with Plate. $3.50.

Stinde, Julius. The Buchholz Family. Translated by L. Dora Schmitz. New York: Charles Scribner's Sons. Pp. 262. $1.25.

Elliott, Henry W. Our Arctic Province, Alaska and the Seal Islands. New York: Charles Scribner's Sons. Pp. 465, with Plates and Maps. $4.50.

Moerlein, George. A Trip around the World. Cincinnati: M. & R. Burgheim. Pp. 205, with Colored Plates.

POPULAR MISCELLANY.

A Boy's Lesson in Taxidermy.—Mr. Frederick G. Mather, of Albany, communicates to us the following directions in regard to "The Best Mode of Stuffing Birds," which were found in an old portfolio, and which recall lessons that were given by one of the learning taxidermists in the country a generation ago. He has followed his boyish notes to the letter. *Materials.*—A glover's three-cornered needle; a knitting-needle sharpened and fixed in a handle, and a sharp knife; arsenical soap, prepared as follows: Pulverized arsenic, two pounds; potash, in powder, twelve ounces; camphor-gum, five ounces; white soap, two pounds; lime in powder, four ounces. Shave the soap into small pieces; place it in a pipkin over a slow fire, and add a little water; stir with a wooden spatula till the soap is dissolved; take it off and add potash, stirring till they are well mixed; add the lime by littles, and then the arsenic, stirring till all are internally mixed; when nearly cold add the camphor, dissolved in strong alcohol; if it becomes too thick, add water sufficient. Let the bird lie two to four hours before skinning. Don't squeeze the head. Swab out the throat with cotton and put in powdered plaster of Paris; then stuff cotton into the mouth, which presses the plaster into all the cavities of the head. Pass a thread or string through the nostrils and tie it; then stuff cotton into the nostrils. The use of the string will be seen hereafter. The cotton and plaster prevent any fluids from issuing out of the head and spoiling the skin. Having smoothed the feathers carefully with cotton, lay the bird upon a piece of thick pasteboard, or a thin board covered with canton flannel, soft side up. Place the bird upon this with the head toward the left hand. Separate the legs and feathers, and at the end of the breast-bone begin to cut through the skin, downward. If blood or other fluids issue, put in plaster of Paris, which will absorb them. Do left side in the same manner, cutting muscles and flesh from the body. Cut muscles of wings. The membrane of the ear must be undermined by a knife, and the knife forced upward, bringing out the ends nearest the bill. Gouge out the eyes. Clear away the brain, tongue, and muscles. Wash inside the skull with arsenical soap, and fill the skull full of powdered arsenic; then press a piece of cotton into the sockets. Leave the bones of the wing, and cut the muscles. Insert a thread at the other end of the bone in the skin. Break the knob off at the end of the wing-bone. Take the muscles out of the legs, and sometimes take the fat off the legs. Lubricate with arsenical soap, and wind the bone with cotton. Then take and tie the wings with their threads, not too tight. Lubricate the whole of it with arsenical soap. Get the ball of cotton out of the nostrils. Take a little awl, the size of a wire, and run it behind the toes to the joint; then straighten the legs and tie the bone to the wire. Take the cotton off and put more on with arsenical soap. Prepare a cork body of the length of the bird, and as large round as a large-sized bottle-cork. Then take three wires, two for the legs—which are already in the legs—and one for the neck. Join them to the cork body, leaving them to project three or four inches outside the real body. Wind cotton on the wire till it becomes as large as the neck, and lubricate with arsenical soap. Wind cotton around an instrument like a knitting-needle till it is about the size of your little finger, and take them off—as fast as made—and lay them on under and around the cork body. Press it from time to time, and put in arsenic-powder. Insert leg-wires. Don't get the legs too far back, or the breast too full. More arsenic. Begin at the upper part to sew up. Get glover's three-cornered needles. Fix the tail nicely. Put a little aqua ammonia in the eye-sockets, and let it remain for an hour. Then clear away all sorts of matter and put putty in. Then take a glass eye and imbed it in the putty, not letting the latter show.

Scientific Novels.—These would serve a better purpose if the exigencies of plot and thrilling situation did not require the inculcation of so much pseudo science. The student in college has to unlearn many things he learned at home from his Jules Verne. A lately published "Romance of Evolution" * is a striking example of the scientific misrepresentation needed to make what is known as a good story. The hero of this unique novel is evolved from ordinary mankind, as Maud S. was evolved from ordinary horse-kind, by artificial selection, and his wonderful development is supposed to have been achieved in seven generations. His development is not in certain directions at the expense of others—the usual result of artificial selection—but it is in *all directions* at one and the same time! In the short space of two hundred years the selected family advances from mediocrity, not in straight lines, but in an expanding circle, to the ideal of human perfection—the hero. He is a "demigod"—physically and intellectually, morally and spiritually. In this universal development are displayed, of course, the most incongruous combinations: savage valor, for instance, in overcoming single-handed a horde of mountain brigands armed with *rifles*, and "Christ-like goodness" in forgiving their chief, who has subjected him to long hours of torture; the rude simplicity of a wild man of the mountains and the æsthetic tastes of a Parisian. It was necessary to the plot that, though subjected to tortures which would have destroyed an ordinary man, the "demigod" should escape and immediately perform prodigies of prowess; hence the explanation is given: "That his skull was not fractured by the terrible blows it had received was due, under Providence, to the unequaled texture and elasticity of that helmet of Nature; that his cords and sinews were not broken or permanently injured, and his nervous system shattered, in the excruciating ordeal which followed, was because they were of Nature's best handiwork, compacted to endure the severest tests that mortality can sustain" (p. 294). How much longer could Maud S. endure blows of an axe upon her dainty forehead than a horse of humble pedigree? As a mere story, the book possesses a certain power and fascination; but as a contribtion to the literature of evolution, it is, like most scientific novels, a failure.

* "A Demigod." Harper & Brothers.

Balance among the Physical Functions.—Dr. H. C. Wood, of Philadelphia, maintains that, to make it possible to live to a good old age, the several vital organs must be approximately equal in strength. The man of ordinary physique, who possesses this fortunate balance of power, will in all probability outlive an athlete whose development has been unequal. Excessive strength in one part is, in fact, a source of danger. An over-developed muscular system invites dissolution, because it is a constant strain upon the less powerful organs, and finally wears them out. Death, in the majority of cases, is the result of local weakness. It often happens that a vital organ has been endowed with an original longevity less than that of the rest of the organism, and its failure to act brings death to other portions of the system, which in themselves possessed the capabilities of long life. The fact of having succeeded in life, with the satisfaction and comfort it brings, contributes to the prolongation of existence, while failure, with its resultant regrets, tends to shorten it. In old age, the organs possess less elasticity to meet and overcome such strains as can be invited with impunity in youth. Hence the old should be spared the strains. It is also desirable that, as their years advance, they should make their personal habits the subject of careful study, and, with the help of some wise counselor, regulate their daily life in accordance with the changed conditions of their animal economy. This is particularly the case with reference to diet.

Artificial Precious Stones. — The trade in artificial precious stones has become quite important, and the manufacture of them has reached a considerable degree of perfection.

The products of some of the shops would almost deceive an expert; but the test of hardness is still infallible. The beautiful "French paste," from which imitation diamonds are made, is a kind of glass with a mixture of oxide of lead. The more of the latter, the brighter the stone, but also the softer, and this is a serious defect. The imitation stones are now so perfectly made, and are so satisfactory to those who are not very particular, that their influence begins to be felt in the market for real stones. By careful selection of the ingredients and skill and attention in manipulation, the luster, color, fire, and water of the choicest stones are, to the eyes of laymen, fully reproduced. There are a few delicacies of color that can not be perfectly given, for they depend on some undiscoverable peculiarities of molecular arrangement and not on chemical composition, but the persons who are to buy the stones know nothing of that. Yet Sidot, a French chemist, has nearly reproduced these peculiarities, including the dichroism of the sapphire, with a composition of which the base is phosphate of lime. Two other French chemists, Fremy and Feil, have produced rubies and sapphires having the same composition with the genuine stones, and nearly equal hardness.

The Future of Political Economy.—Mr. John Biddulph Martin, president, said, in the British Association's section of Economic Science and Statistics, that we need not despair of the future of political economy because its teaching, based too often on *a priori* reasoning, and too little on the experience of history, does not always square with the judgments of men. May we not claim that political economy has rather taken up wider ground, than that it has abandoned many of its outworks? It is no reproach to economic science to have done so; to have recognized as matters within its proper scope considerations that the older economists, concerning themselves with wealth in its narrow sense, as the *summum bonum*, and with the desire for its acquisition as the one mainspring of human action, would have regarded as sentimental and philanthropic. Humanity is many-sided, its units do not lend themselves to grouping or combination with the precision of mathematical symbols, and the experiments of the social philosopher are subject to disturbances unknown in the laboratory of the chemist. It is at this point that the statistical method comes in as an inseparable ally of economic speculation. The speaker proceeded to a fuller review of the merits and faults of the statistical method, and then dwelt at considerable length on the tendency of men to accumulate in cities.

Australian Paradoxes.—In connection with the recent determination of the oviparous character of the monotremes, "Nature" republishes the following list of the paradoxes of Australia from a work published in 1832: "But this is New Holland, where it is summer with us when it is winter in Europe, and *vice versa;* where the barometer rises before bad weather, and falls before good; where the north is the hot wind, and the south the cold; where the humblest house is fitted up with cedar; where the fields are fenced with mahogany, and myrtle-trees are burned for fire-wood; where the swans are black and the eagles white; where the kangaroo, an animal between the squirrel and the deer, has five claws on its fore-paws and three talons on its hind-legs, like a bird, and yet hops on its tail; where the mole lays eggs, and has a duck's bill; where there is a bird with a broom in its mouth instead of a tongue; where there is a fish, one half belonging to the genus *Raja* and the other half to that of *Squalus;* where the pears are made of wood, with the stalk at the broader end; and where the cherry grows with the stone on the outside."

A New Incandescent Gas-light.—Mr. Conrad W. Cooke described, in the British Association, the Welsbach system of gas-lighting by incandescence. It consists in impregnating fabrics of cotton or other substances, made into the form of a cylindrical hood or mantle, with a compound liquid composed of solutions of zirconia and oxide of lanthanum (or with solutions of zirconia with oxides of lanthanum and yttrium). This mantle, under the influence of a gas-flame, is converted into a highly refractory material capable of withstanding the highest temperature that can be obtained from the most efficient form of atmospheric burners. Under the influence of such temperatures it glows with a brilliant incandescence, very white and steady. The light emitted is, at a distance, hardly distinguishable from that of a twenty-candle incandescent lamp, while a yellower light may be obtained by modifying the composition of the impregnating liquid. A saving of from fifty to seventy-five per cent of gas is made with this light, and it is, moreover, smokeless.

The "Racket" of Society.—"The Spectator," discussing the "wear and tear" or "racket" of London society, observes that "wear and tear" implies not regular and natural use and tension of the powers, but a dragging in opposite directions, "such as is produced, for example, by the attempt to combine intellectual effort with a perfectly inconsistent amount of social effort; to carry off grave anxieties with a display of vivacity; to unite an unconstrained manner which implies a mind at ease with a concentration of effort implying a mind always vigilantly preparing for its next step." It means "the simultaneousness of a strain which is comparatively easy in cases of fully concentrated effort with that interchange of feeling which is natural only when there is no prior claim on the attention; the interference of social duties with professional duties; the *making* time for one thing, when all the time there is is really pre-engaged for another thing; the squeezing of gayety out of a preoccupied mind, or of severe but reluctant thought out of preoccupied feeling." This "tear" could be easily avoided by taking the natural precautions. "For nothing is easier than for the busy to claim and to insist on a certain amount of seclusion sufficient for the purposes of their work, if they would but recognize fairly that a great deal of what is called amusement doubles and trebles the tension of men's work." Regarding conversational intercourse with people, "A person of any mind will get more out of two or three conversations in a week or a month with the right people than he could get out of twenty or thirty." If people only realized how little pleasure their company can give when they are exhausted by the mechanical friction of the "racket" of society, they would, even from self-respect, forbear. The best evidence that persistent society-haunting is useless or mischievous is the relief with which those are received who have been long kept by any good reason out of the vortex of society, and return to the world with a little of the clearness of mind and confidence of view which the social racket saps and ultimately destroys. Social stimulants do the same kind of mischief that alcoholic stimulants do, though in a different region; and, "like an intoxicating drink, the racket of society becomes most indispensable to the very people whom it most seriously injures."

The Brocken and its Mist-Effects.—The Brocken is the culminating point of the Harz Mountains, and in its general form represents an oval slightly inclined from northwest to southeast. Its highest elevation is 1,141 metres above the sea. In consequence of its isolation in the midst of a lowland region, it is immediately exposed to the moist winds from the North Sea, and presents some very remarkable meteorological phenomena. The mean annual temperature at the top of the Brocken is about 36° C., and nearly the same as that of Tromsö in Norway, in 70° of latitude; but while Tromsö enjoys a summer in which potatoes and barley may be grown and fruits will fully ripen, no efforts to cultivate such plants on this range have succeeded. Clear days are rare on the Brocken, and the summit of the mountain is veiled by clouds nearly every morning; but the topmost peak may often be seen above the vapors which cover the slopes below; and it is not rare for the fogs to be so thick and so sharply defined that a man of the ordinary stature standing among them will have his head above the vapor while the lower part of his body is still densely involved. It is under such conditions as these that the "specter of the Brocken," a celebrated attraction to travelers, may be seen at the rising and setting of the sun, particularly in winter. The spectators view their silhouettes projected, in exaggerated proportions, upon the surface of the mist, which seems to rise like an immense curtain from out of the clouds. Their heads appear to be surrounded with an aureole, while the shadows of other objects, notably of the tower of the inn, assume gigantic dimensions, all within the compass of a grand picture-frame defined by a rainbow. A similar phenomenon has been observed on the top of the Egischhorn, above the Aletsch glacier, in Switzerland. Another series of striking effects is produced in the Brocken by the excessive precipitation and deposition of moisture. Guests at the inn say that the telegraph-posts sometimes appear a yard thick under the accumulation of frost upon them, and the wires are frequently broken under the weight of the ice with which they become covered. The extremely fine drops of water, suddenly frozen, deposit themselves in crystalline figures upon everything against which the wind drives them. Under these effects Brocken landscapes take on a fantastic aspect in winter, which is heightened, when the sun is shining, by the reflections from the innumerable minute crystals.

Decrease of the English Death-Rate.—The English Registrar-General shows, from a review of the mortality of England during the ten years (1871–'80), that the mean annual death-rate has fallen to 21·27 per thousand, the lowest average since civil registration began. With this general fall is an increase in the death-rates in the later periods of life. This is also significant of improved tenure of life, for it shows that a larger proportion of persons live to be old enough to die in the later periods. Dr. Ogle gives the credit of the lessened death-rate among young people to improved sanitation, which has removed many fruitful sources of mortality, while by aiding the survival of weakly persons it may have had a tendency to increase the death-rate of the later periods. The changes in the death-rates, Dr. Ogle adds, "have given to the community an annual addition of 1,800,047 years of life shared among its members; and, allowing that the changes are the direct consequence of sanitary interference, we must regard this addition of nearly two million years of life as an annual income derived from money invested in sanitation."

Cardiac Overstrain.—The "Lancet" improves the occasion of the recent deaths of two persons by syncope after severe muscular exertion—one during an Alpine expedition, and the other after a sharp row on the river—to enforce the necessity of undergoing suitable preparation by training before engaging in unusual exercises. Both of the deceased persons, it says, "were of an age when degenerative changes in the muscular tissue of the heart or of the vessels would hardly be expected, and the syncope must have resulted from the sudden strain thrown on the cavities of a heart weakened previously by a long period of inactivity, and before the concordant action between the heart and great vessels had been established. This is always a danger when violent exercise is suddenly undertaken, and the mischief is of course greater in elderly persons than in young adults."

How Rice is Cleaned and Polished.—According to the reports transmitted by our consular officers from England and Germany, the processes for cleaning rice are quite complicated. The grain, after having been taken to the top story of the mill and blown and sieved, is divested of its paddy or husks by passing it over a sieve having a jumping action or tapping motion at the bottom, or by being carried between stones like those usually employed for grinding wheat. These stones, in England, are of a composition of magnesian calcinate and emery, and always keep a sharp face through the difference in hardness between the emery and the magnesian cement. Shelling-stones covered with cork have been tried and given up; and in Italy a surface of hard wood set on end is sometimes used, like the Burmese native hand-mills. In the process of shelling, a meal or flour is made from the crushing of the rice-paddy and the three pellicles which, inside of the paddy, inclose the grain, and is removed by apparatus adapted for the purpose. The husks are separated from the grain by a blast or exhaust, and the pellicles which still adhere to the grain by bruising in a mortar. The rice is then winnowed again, milled, re-screened, and polished, in polishers that generally consist of a sheep-skin-covered drum—the skin of a South Down is preferred, on account of the thickness of its wool—which revolves inside of a fixed wire casing about eighteen hundred to two thousand feet per minute at the periphery. The form of apparatus mostly used is that of an inverted frustum of a cone. The general principle of its operation is that of a wooden cylinder revolving in a wooden mantle or mantle of wire-work, between which the rice has to circulate and be rubbed. Sometimes the rice, as it passes into the polisher, is subjected to an infusion of indigo toned down with rice-flour to a pale blue. This gives the rice a bluish tint, that is liked better in England than the natural creamy whiteness of the grain itself. On leaving the polishers, the grain is blown or aspirated, and separated into whole rice, broken rice, and rice of different sizes. A recent "improvement" is to pass the grain through an oiling-machine so as to give it a smoother and glossier surface.

The Volcanic Eruption in New Zealand.—The recent volcanic eruption which laid waste a large tract of country in New Zealand was one of the most remarkable that has taken place in civilized lands since the eruption of Mount Vesuvius in A. D. 79. It also presented many features in common with the Vesuvian eruption. Like that, it took place from a volcano which had never been known to exhibit activity since man had lived in the region; like it, it was distinguished by immense emissions of ashes and the burial of towns; and as the Vesuvian eruption numbered among its victims the naturalist Pliny, so in this one the young Englishman Brainard was overtaken while interested in observing the phenomena. The district afflicted by the eruption was becoming a favorite resort for tourists from all parts of the world on account of the remarkable phenomena and the beautiful aspects of scenery it presented, which in some respects resembled those of our Yellowstone wonderland. It is called the "Hot Lakes" district, and is situated about forty miles inland from the Bay of Plenty, on the east coast of the island. The lakes Rotorua and Rotomahana occupied its central portion, and were divided by fifteen or sixteen miles of "hot-spring country," in which numerous small columns of steam rise from bubbling pools of hot water. The ground around these springs is of the most treacherous character, is frequently broken up by the bursting out of new springs, and has been known to swallow up human beings passing over it. Nine miles from Rotomahana Lake rose Mount Tarawera, a curious truncated mountain two thousand feet high, whose summit was regarded by the natives with a peculiar veneration, and two adjacent peaks. On the borders of the lake were the "pink and white terraces," curved formations of sinter, of the color named, rising stairwise for about one hundred and fifty feet in height, with clear water running over them or standing in pools on their flats, the constant depositions from which added to their growth. The volcanic disturbances began on the night of the 9th of June, with a frightful earthquake-shock, followed by the burst of a glaring, pillar-shaped light from the top of Mount Tarawera, while over it hung a great black cloud. The scene was accompanied, according to the accounts, with loud reports, heavy shocks, tongues of flame, and the shooting of fire-balls. Then came a shower of ashes, mud, and stones over the township which buried the village of Wairoa under a deposit of from ten to twenty feet in thickness. About a hundred lives were lost, among them those of a part of the family of Mr. Haszard, the schoolmaster. The "pink and white terraces" were blown into the air, and the lake on whose borders they stood was ingulfed. Mud cones, vomiting forth steam and stones and mud, occupy their place. The aspect of the mountains was changed, and a large fissure was opened east of Mount Tarawera. As seen from New Plymouth, one hundred and fifty miles distant, the column of ashes rising into the air appeared to be about twenty-two thousand feet high. The noise of the explosion was heard at Christchurch, three hundred miles away; and vessels sailing one hundred and thirty miles away found the air thick with fine dust which settled on their decks. A hurricane arose about an hour after the explosion, blowing toward the scene of volcanic activity, and then in a few hours suddenly ceased, when ashes fell. The weather also became very cold. It is said that, about a fortnight before this disaster occurred, a wave three feet high suddenly arose on Lake Tarawera, at the foot of the mountain, and washed the boats out of the boathouses.

Book-Worms and their Food.—The book-worm—that is, the larva that eats books and binding—is named, according to Mr. Sydney Klein, *Tenebrio mollitor*, and is a coleopter. It is attracted by the gluten in the paste used in binding the books; and Mr. Klein says that a dark flour—the "whole-wheat" flour—coming from America, and rich in gluten, is used largely for making paste and in the manufacture of cardboard. Hence the *tenebrio* is likely to find rich pastures in the books of to-day if he is admitted to them, and they are not "medicated." Light is thrown on this subject of medication by the observation of Mr. Russell Gubbins that the *tenebrios* have an apparent choice of colors. His *tenebrios* "had a decided preference for dark-colored paper," while "light-yellow paper, almost without exception, escaped." One of the papers that escaped was a light green—an arsenical paper. The light-yellow paper was probably colored with chrome-yellow, chromate of lead. So it appears that the insects may be fought by exercising judgment in coloring the papers which are to receive the paste.

Curious Central African Peoples.—The Rev. T. J. Comber, a Baptist missionary, has given to the Royal Geographical Society an account of his voyage, in company with the Rev. George Grenfell and in the missionary steamer Peace, up the Congo to the Bangala, and up the Bochini to the junction of the Kwango. The width of the river, from Stanley Pool to the Bochini, varies from twelve hundred yards to two miles. It is swift and strong, and navigation has to be performed carefully, on account of up-cropping feldspathic rocks An interesting feature of the first days' sails was the little clusters of huts on the sand-banks in twos, fours, and sixes, inhabited by Ba-Buma people, who sold beer and caught fish. The people are ruled by a queen, Nga Nkabe, whose husband, or "prince consort," Nchielo, "knows his place, and sits quietly by, smoking his pipe meekly and philosophically, while his wife rules." She is tall, brawny, and dignified, and about fifty years old, but "did not seem to think it beneath her to take her paddle, and, entering into a little canoe with another woman, to go herself to cut us a bunch of plantains." Her great desire was to possess a double-barreled gun, and she was evidently pleased with a present of cloths, a big bell, a soldier's great-coat, and some brass. The Ba-Buma were the best specimens of the African encountered on the journey. The women wear brass collars weighing from twenty-five to thirty pounds. The most primitive people seen by the travelers were the Ikelemba, about the great Ruki River, who go about with bow and arrow, or spears and shield, or a murderous sacrificial knife, wearing hats made of monkey-skins, of which the head of the animal comes to the front of their heads, while the tail hangs down behind. They are cruel, ingeniously cruel, and indulge among other amusements in chasing their human victims across the country as our hunters would chase a fox. Another exercise of their braves is inflicting "death by the knife," in which the head of the victim is so adjusted that, when it is cut off by a blow of a sickle-shaped knife, it is tossed by the spring of a sapling high into the air. In strange contrast with these revolting practices was "a pretty little performance by children, lasting several hours, and consisting, first, of clever dancing, and then of a little bit of operatic acting, after the style of a Greek play, the chorus part of which was very prettily rendered by little girls of eight to twelve years old. A strange-looking bier was carried in on the shoulders of four men. On the top of it was somebody or something covered over with red baize cloth. Sitting up at one end was a little girl looking sad and mournful. This bier (a native bamboo bed) was placed on the ground and surrounded by the 'chorus'—six little girls. A plaintive song was chanted by a woman who came to the side of the bier, which was chorused by the little girls. It was really pretty and effective; the idea of a drama in Central Africa surprised us altogether. We could understand but little of the words sung, but caught the frequent repetition at the end of the chorus of 'Ka-wa-ka' ('He is not dead'). After a time the spells of incantation were considered to have worked, and there was a noticeable heaving and shuddering in the covered mass at the girl's feet. The red cloth was drawn aside, and a girl was discovered, her chest heaving quickly and her limbs trembling as if in a paroxysm of epilepsy. Two persons came forward, and, taking her by her arms, raised her to her feet. . . . The little performance was enacted to please the white man."

The Life-Term of Animals and Plants.— Dr. August Weissman regards the life-terms of animals and plants not as fixed and the results of internal processes, but as modifiable according to external conditions and the incidents of the struggle for existence. The idea that the immediate cause of death is the wearing away of the tissues does not agree with the theory that the tissues are undergoing constant changes of substance, resulting in alteration and restoration, nor with the fact that some kinds of cells go on reproducing themselves indefinitely, or with the other fact that some animals perish, when apparently in full vigor, immediately after performing the generative function. It would seemingly be better to look for the cause of death in the terminability of the reproductive powers; and we might explain the difference in the possible life-terms of different species by supposing that the number of cell-generations which can proceed from the egg-cells normally differs in each species. A perishable material is provided for the inevitable wear and destruction of the body, and the function of unlimited increase has been confined to a smaller number of cells, which we call reproductive cells. We have in this and in some other facts justification for supposing that the life-force is essentially and originally unlimited. This appears to be actually the case with some of the lower organisms. They may be killed in various ways, it is true; but, so long as the conditions essential to life are around them, they live, and bear within themselves the conditions of never-ending existence. The process of division by which ana mœba becomes two is sometimes spoken of as death and propagation, but there is no death in the case. Both parts equally live, and either might with equal right consider itself the mother and the other as the daughter body; and, if there be any transmission of consciousness and individuality, it is alike to both. We have no reason for supposing that either of the bodies will eventually die while the other lives; for, so far as our observation enables us to predict, both will go on dividing continuously without death taking place in any part. To account for the loss of the property of perpetual existence in the many-celled organisms, we may observe that a division of labor has been established among the cells as their structure has become more complex; and we have the life-supporting or somatic cells, and the reproductive cells, the former of which perform their several functions and cease to live, while the latter retain the faculty of continuous division or multiplication, and continue to live as the seed of offspring. They could not lose these properties without risking the extinction of the species. Death could not be introduced as a normal liability of one-celled organisms, because the two functions are united; but, in more complex organisms where there is a division of function, it is possible and exists. The normal vital term of the somatic cells appears to be contingent on the completion of the faculty of reproduction.

NOTES.

T. Egleston, in a paper on the causes of decay affecting building-stones, especially mentions such causes as depend on the removal of an ingredient by decay or decomposition. He observes that dolomitic limestones, which in some regions, in the case both of the native ledges and of monuments, crumble to sand, owe their disintegration to the fact that they are to a large extent mixtures of true dolomite and limestone; and that the limestone, the most soluble portion, is dissolved and removed by percolated carbonated waters.

A tunnel is projected, to be bored under Gray's Peak, in the Rocky Mountains. It will be placed 4,441 feet below the summit of the mountain, will be 25,000 feet long, and will give direct communication between the valleys in the Atlantic slope and those of the Pacific side, with a shortening of some three hundred miles in the transmontane distances.

Dr. P. H. Dudley recently described to the American Institute of Mining Engineers two cast-iron car-wheels which a chemical examination had shown to be almost precisely the same in composition, but one of which was good, while the other was nearly worthless, for its purpose. From this, it appears that the value of articles of iron and steel is largely dependent on other conditions than that of mere chemical composition. Mr. F. L. Garrison has found the microscope a very useful test for determining the qualities of metals, through the revelations which it affords of the arrangement of their particles and their structure.

The British Association's committee to observe the migration of birds has learned that birds on their arrival at the British Isles, as a rule, avoid high cliffs, and prefer to enter river-valleys, whence they spread gradually over the area embraced by the river's tributaries.

Mr. E. W. Bucke has determined by soundings the depth of the tubes of several geysers of the Rotorua district, New Zealand. In the case of the extinct geyser of Te Waro, he was let down the tube. At thirteen feet below the surface it opened into a chamber fifteen feet long, eight feet broad, and nine feet high, from one end of which another tube led downward to an undetermined depth. The author was satisfied, from his intercourse with the natives of the district, that by constant observations on the direction of the wind and the condition of the atmosphere, they had learned to prognosticate the movements in all these hot springs with wonderful accuracy. He had also observed during his residence that the geysers were in eruption only when the wind blew from a particular quarter.

Mr. Robert Capper proposed, in the British Association, a railway to connect the heart of Africa with London in ten days, as "a feat worthy of the age we live in." He would advocate the building of a railway from the two rivers Niger and Congo toward each other, and north and south at the rate of a mile a day, to form a spine through the continent. It would give the missionaries and traders two sides to work from, instead of one, as now.

Weeds are plants in the wrong place. They all probably have their right places and their uses somewhere in Nature's economy, though these are sometimes hard to appreciate. The most of them may serve to keep some desolate spot from being entiely bare, and the decay of their repeated generations furnishes mold to the ground, and may in time make it fit to bear something better. They all, too, have elements of beauty, and these will reveal themselves to every one who diligently searches for them. Many of them, if they were not weeds, would be prized as choice flowers, and some of them have been such.

Commenting on the vital statistics of one of the parishes of London, Dr. Meymott Tidy calls attention to the fact that the death-rate of England is decreasing, and that 150 people are added yearly to every 10,000 of the population. From this he prognosticates that at the present rate of increase the population of the country twenty generations hence will be 27,200,000,000, or enough, if distributed no more densely than the present population, to fill twenty earths. From 5,000,000 in the reign of Henry VIII, the population of England rose to about 7,500,000 in the early part of the reign of George III, and then, under the impulse of a long period of commercial prosperity, to 16,000,000 at the time of the repeal of the corn laws. Now, 24,000,000 people are housed and fed in England and Wales, and depend on other countries for half of their food. Dr. Tidy regards the present increasing population and declining trade as serious facts.

Dr. J. Burney Yeo mentions, as among the special applications which are made of the waters of the mineral springs of Continental Europe, the treatment of biliary obstructions and the plethoric forms of gout, at Carlsbad; of atonic gout, at Rogat; of calculous disorders, at Vichy and Contrexéville; of chronic articular rheumatism and gout, at Aix-les-Bains; of diabetes, at Neuenahr and Carlsbad; of obesity, at Marienbad; of gouty and catarrhal dyspepsia, at Hamburg and Kissingen; of anæmia, at Schwalbach and St. Moritz; of asthma, at Mont Dore; of throat affections, at Cauterets and Eaux-Bonnes; of scrofulous glandular affections, at Kreuznach; and of the great variety of chronic skin affections, at Aix-la-Chapelle, Cannstadt, La Bourbole, and Uriage.

Describing, in the British Association, his optical studies in the essential oils, Dr. Gladstone, after explaining how the refractive equivalent of an organic compound may be used to determine its constitution, pointed out that the dispersive equivalents can be similarly used. He also discussed the refraction and dispersion equivalents of the turpenes, citrenes, camphor, and some other members of the group of essential oils, and showed how their values are of service in determining the constitution of those bodies.

H. R. Mill has determined the salinity of the water from point to point in the Firth of Clyde and the Firth of Forth. The distribution of salinity in the Firth of Forth is constant all the year round, while periodical variations are observed through the whole mass of the water in the Firth of Clyde. It is evident that in the Forth River entrance, a mixture of river- and sea-water takes place by a true process of diffusion, and a constant gradient is maintained from river to sea. The dissolved matter of fresher water was found richer than sea-water in calcium carbonate.

The "Revue Scientifique" claims the first thought of the germ theory of disease for a Dr. Goiffon, who died at Lyons more than one hundred and fifty years ago. He believed, in 1721, that diseases like the plague could be caused only by minute insects or worms, too small to be seen, perhaps, but nevertheless really existing. He also believed that the conveyance of infection could be explained by their activity and propagation.

An observatory is in building at Sonnblick, in the Tyrolese Alps, ten thousand feet above the sea, which will be the highest of the kind in Europe. The mountain is relatively easy of access, with mines halfway up its slopes, and a wire rope-way in operation leading up to them. The observatory will be in telephonic communication with the mines, and thence in telegraphic communication with whatever spot it may be desirable to reach.

Professor Odling has described a process in which benzoic acid, when heated in sealed tubes at about 260° with an aqueous solution of zinc chloride, is decomposed, and yields chiefly benzene, together with a small quantity of diphenyle.

OBITUARY NOTES.

Mr. Eli Whitney Blake, the inventor of the Blake stone-crusher, who recently died at his home in New Haven, Connecticut, was the founder of the Connecticut Academy of Arts and Sciences, and for several years its president. He communicated several papers to the "American Journal of Science" and other scientific publications; and a number of these were published together in 1882, under the title of "Original Solutions of several Problems in Aërodynamics." His stone-crusher is in nearly universal use.

Professor H. A. Bayne, Ph.D., of the Royal Military College, Kingston, Ontario, has recently died. He was a student under Liebig, Bunsen, and Dumas.

Herrmann Abich, an eminent Austrian geologist, died on the 1st of July, nearly seventy years of age. He began his scientific career in 1831 by the publication of a memoir on the minerals of the Spinel family. At a later period he devoted special attention to the phenomena of volcanic action; he published an atlas of views of Vesuvius and Etna in 1837, and a work on volcanic formations in 1841. He investigated the Caucasus region and Southeastern Europe, and was, at the time of his death, superintending the publication of the "Geologische Forschungen in den kaukasischen Ländern," his greatest work.

The death is reported of M. Ernest Desjardins, professor in the Collége de France, aged eighty-three years. His principal labors were upon problems of comparative geography, in which missions executed by him in Egypt, Italy, and the basin of the Danube, led to interesting discoveries. His most important publications were on the topography of Latium, the ancient geography of Italy, and the geography of ancient Gaul.

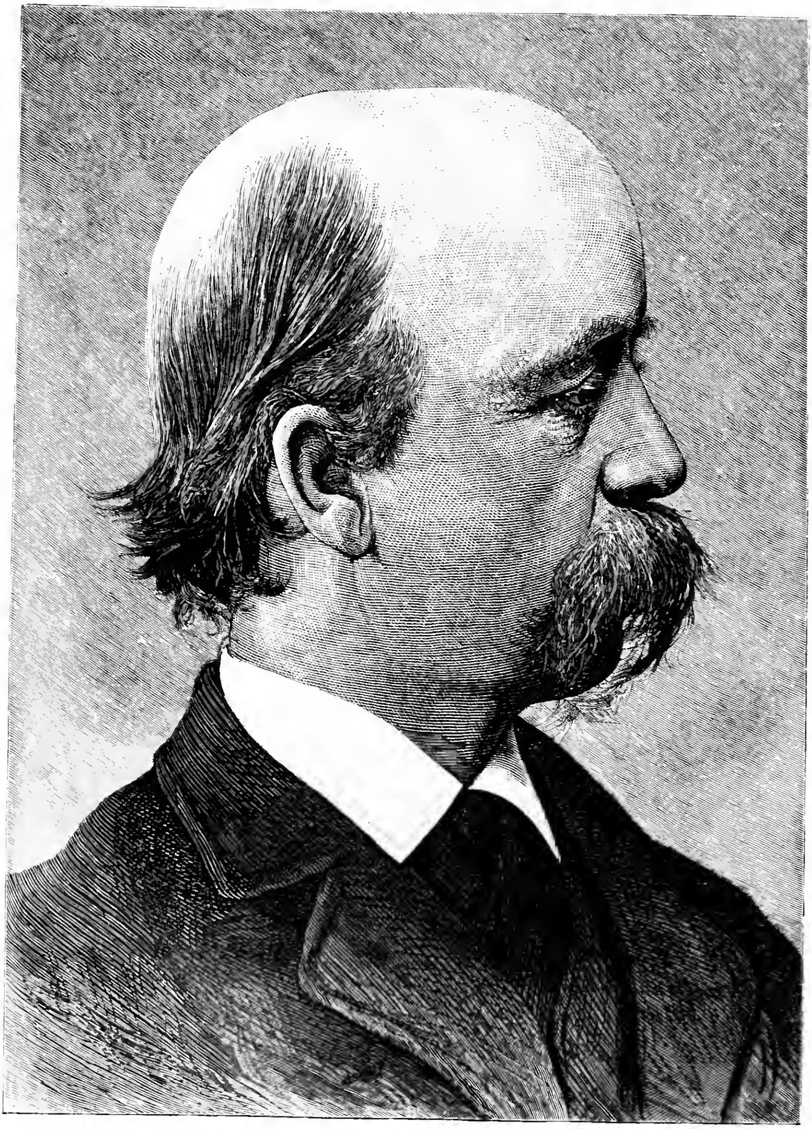
Alessandro Dorna, Director of the Astronomical Observatory at Turin, died in August last, aged sixty-one years.

M. Paul Bert, the eminent French physiologist, died in Tonquin, where he occupied the position of French resident in Annam and Cochin-China, on the 11th of November. He had held professorships at Bordeaux and Paris; was elected to the National Assembly in 1874; was an efficient Minister of Public Instruction in Gambetta's Cabinet; and was a pleasing writer on scientific and educational subjects.

Professor Frederick Settle Barff, inventor of the Barff process for preventing the corrosion of iron and of an antiseptic compound, died on the 11th of August, aged sixty-two years. The record of his life is one of useful investigation and invention. He delivered at different times "Cantor Lectures" of the Society of Arts on "Artistic Colors and Pigments," "Silicates, Silicides, Glass, and Glass-Painting," and "Carbon, and Certain Compounds of Carbon, treated principally in reference to Heating and Illuminating Purposes"; also juvenile lectures, for 1878, on "Coal and its Compounds." He was awarded the Society's medal for a paper on "Zinc-White as Paint, and the Treatment of Iron for the Prevention of Corrosion," and a second medal for his paper on "A New Antiseptic Compound." He held the positions of Assistant Professor of Chemistry at University College, London, Examiner in Chemistry for the Natural Science Tripos, Cambridge, and Professor of Chemistry at the Catholic University at Kensington, and in the Jesuits' College, Beaumont.

Dr. John P. Gray, Superintendent of the New York Lunatic Asylum, died in Utica, November 29th, of Bright's disease, aged sixty-one years. After having been assistant physician at the lunatic asylum for several years, he was appointed its superintendent in 1854. He was regarded as one of the foremost experts in insanity in the United States.

Professor Panum, the great Danish physiologist, has recently died in Copenhagen, in the sixty-fifth year of his age.



CHARLES C. ABBOTT.

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THE LAWS OF HABIT.

By Professor WILLIAM JAMES.

WHEN we look at living creatures from an outward point of view, one of the first things that strike us is that they are bundles of habits. In wild animals, the usual round of daily behavior seems a necessity implanted at birth; in animals domesticated, and especially in man, it seems, to a great extent, to be the result of education. The habits to which there is an innate tendency are called instincts; some of those due to education would by most persons be called acts of reason. It thus appears that habit covers a very large part of life, and that one engaged in studying the objective manifestations of mind is bound at the very outset to define clearly just what its limits are.

The moment one tries to define what habit is, one is led to the fundamental properties of matter. The laws of Nature are nothing but the immutable habits which the different elementary sorts of matter follow in their actions and reactions upon each other. In the organic world, however, the habits are more variable than this. Even instincts vary from one individual to another of a kind; and are modified in the same individual, as we shall later see, to suit the exigencies of the case. The habits of an elementary particle of matter can not change (on the principles of the atomistic philosophy), because the particle is itself an unchangeable thing; but those of a compound mass of matter can change, because they are in the last instance due to the structure of the compound, and either outward forces or inward tensions can, from one hour to another, turn that structure into something different from what it was. That is, they can do so if the body be plastic enough to maintain its integrity, and be not disrupted when its structure yields. The change of structure here spoken of need not involve the outward shape; it may be invisible and molecular, as when a bar of iron becomes magnetic or crystalline through the action of certain outward causes, or India-rubber becomes friable, or plaster "sets." All these changes are rather slow; the material in question opposes a certain resistance to the modifying cause, which it takes time to overcome, but the gradual yielding whereof often saves the material from being disintegrated altogether. When the structure has yielded, the same inertia becomes a condition of its comparative permanence in the new form, and of the new habits the body then manifests. *Plasticity*, then, in the wide sense of the word, means the possession of a structure weak enough to yield to an influence, but strong enough not to yield all at once. Each relatively stable phase of equilibrium in such a structure is marked by what we may call a new set of habits. Organic matter, especially nervous tissue, seems endowed with a very extraordinary degree of plasticity of this sort; so that we may without hesitation lay down as our first proposition the following, that *the phenomena of habit in living beings are due to the plasticity* of the organic materials of which their bodies are composed.*

But the philosophy of habit is thus, in the first instance, a chapter in physics rather than in physiology or psychology. That it is at bottom a physical principle is admitted by all good recent writers on the subject. They call attention to analogues of acquired habits exhibited by dead matter. Thus, M. Léon Dumont, whose essay on habit is perhaps the most philosophical account yet published, writes: "Every one knows how a garment, after having been worn a certain time, clings to the shape of the body better than when it was new; there has been a change in the tissue, and this change is a new habit of cohesion. A lock works better after being used some time; at the outset more force was required to overcome certain roughnesses in the mechanism. The overcoming of their resistance is a phenomenon of habituation. It costs less trouble to fold a paper when it has been folded already. This saving of trouble is due to the essential nature of habit, which brings it about that, to reproduce the effect, a less amount of outward causality is required. The sounds of a violin improve by use in the hands of an able artist, because the fibers of the wood at last contract habits of vibration conformed to harmonic relations. This is what gives such inestimable value to instruments that have belonged to great masters. Water in flowing hollows out for itself a channel, which grows broader and deeper, and, after having ceased to flow, it resumes, when it flows again, the path traced by itself before. Just so, the impressions of outer objects fashion for themselves in the nervous system more and more appropriate paths, and these vital phenomena recur under similar excitements from without, when they have been interrupted a certain time."

Not in the nervous system alone. A scar anywhere is a *locus minoris resistentiæ*, more liable to be abraded, inflamed, to suffer

* In the sense above explained, which applies to molecular structure as well as to that of grosser parts.

pain and cold, than are the neighboring parts. A sprained ankle, a dislocated arm, are in danger of being sprained or dislocated again; joints that have once been attacked by rheumatism or gout, mucous membranes that have been the seat of catarrh, are with each fresh recurrence more prone to a relapse, until often the morbid state chronically substitutes itself for the sound one. And if we ascend to the nervous system, we find how many so-called functional diseases seem to keep themselves going simply because they happen to have once begun; and how the forcible cutting short by medicine of a few attacks is often sufficient to enable the physiological forces to get possession of the field again, and to bring the organs back to functions of health. Epilepsies, neuralgias, convulsive affections of various sorts, insomnias, are so many cases in point. And, to take what are more obviously habits, the success with which a "weaning" treatment can often be applied to the victims of unhealthy indulgence of passion, or of mere complaining or irascible disposition, shows us how much the morbid manifestations themselves were due to the mere inertia of the nervous organs, when once launched on a false career.

Can we now form a notion of what the inward physical changes may be like, in organs whose habits have thus struck into new paths? In other words, can we say just what mechanical facts the expression "change of habit" covers when it is applied to a nervous system? Certainly we can not in anything like a minute or definite way. But our usual scientific custom of interpreting hidden molecular events after the analogy of visible massive ones enables us to frame easily an abstract and general scheme of processes which the physical changes in question *may* be like. And when once the possibility of *some* kind of mechanical interpretation is established, Mechanical Science, in her present mood, will not hesitate to set her brand of ownership upon the matter, feeling sure that it is only a question of time when the exact mechanical explanation of the case shall be found out.

Of course, a simple habit, like every other nervous event—the habit of snuffling, for example, or of putting one's hands into one's pockets, or of biting one's nails—is, mechanically, nothing but a reflex discharge; and its anatomical substratum must be a reflex arc in the nervous system. The more complex habits, as we shall presently see more fully, are, from the same neural point of view, nothing but *concatenated* discharges in the nerve-centers, due to the presence there of systems of reflex arcs, so organized as to wake each other up successively—the impression produced by one muscular contraction serving as a stimulus to provoke the next, until a final impression inhibits the process and closes the chain. The mechanical problem, then, is to explain the formation *de novo* of a simple reflex arc in a pre-existing nervous system. Here, as in so many other cases, it is only the *premier pas qui coûte.* For a nervous system is nothing but a system of *paths* which the nerve-current follows, between a sensory *terminus a* *quo* and a muscular, glandular, or other *terminus ad quem.* A path once traversed by a nerve-current might be expected to follow the law of most of the paths we know,* and to be scooped out and made more permeable than before; and this ought to be repeated with each new passage of the current. Whatever obstructions may have kept it at first from being a path, should then, little by little, and more and more, be swept out of the way, until at last it might become a natural drainage-channel. This is what happens where either solids or liquids pass over a path; there seems no reason why it should not happen where the thing that passes is not a moving body, but a mere wave of rearrangement in matter that does not displace itself in the line of the "path," but merely changes chemically or turns itself round in place, or vibrates across the line. The most plausible views of the nerve-current make it out to be the passage of some such wave of rearrangement as this. If only a part of the matter of the *path* were to "rearrange" itself, the neighboring parts remaining inert, it is easy to see how their inertness might oppose a friction which it would take many waves of rearrangement to break down and overcome. If we call the path itself the "organ," and the rearrangement of the molecules the "function," then it is obviously a case for repeating the celebrated French formula of "*La fonction fait l'organe.*"

So nothing is easier than to imagine how, when a current once has traversed a path, it should traverse it more readily still a second time. But what made it ever traverse it the first time?† In answering this question we can only fall back on our general conception of a nervous system as a mass of matter whose parts, constantly kept in states of different tension, are as constantly tending to equalize their states. The equalization between any two points occurs through whatever path may at the moment be most pervious. But, as a given point of the system may belong, actually or potentially, to many different paths, and, as the play of nutrition is subject to accidental changes, *blocks* may from time to time occur, and make currents shoot through unwonted lines. Such an unwonted line would be a new-created path, which, if traversed repeatedly, would become the beginning of a new reflex arc. All this is vague to the last degree, and amounts to little more than saying that a new path may be formed by the sort of *chances* that in nervous material are likely to occur. But, vague as it is, it is really the last word of our wisdom in the matter.‡

* Some paths, to be sure, are banked up by bodies moving through them under too great pressure, and made impervious. These special cases we disregard.

† We can not say *the will*, for, though many, perhaps most, human habits were once voluntary actions, no action can be *primarily* such. While an habitual action may once have been voluntary, the voluntary action must before that, at least once, have been impulsive or reflex. It is this very first occurrence of all that we consider in the text.

‡ Those who desire a more definite formulation may consult J. Fiske's "Cosmic Philosophy," vol. ii, pp. 142–146, and Spencer's "Principles of Biology," sections 302 and 303, and the part entitled "Physical Synthesis" of his "Principles of Psychology." Mr.

It must be noticed that the growth of structural modification in living matter may be more rapid than in any lifeless mass, because the incessant nutritive renovation of which the living matter is the seat, tends often to corroborate and fix the impressed modification, rather than to counteract it by renewing the original constitution of the tissue that has been impressed. Thus, we notice after exercising our muscles or our brain in a new way, that we can do so no longer at that time; but after a day or two of rest, when we resume the discipline, our increase in skill not seldom surprises us. This has led a German author to say that we learn to swim during the winter and to skate during the summer.

Dr. Carpenter writes:* "It is a matter of universal experience, that every kind of training for special aptitudes is both far more effective, and leaves a more permanent impress, when exerted on the *growing* organism, than when brought to bear on the adult. The effect of such training is shown in the tendency of the organ to 'grow to' the mode in which it is habitually exercised; as is evidenced by the increased size and power of particular sets of muscles, and the extraordinary flexibility of joints, which are acquired by such as have been early exercised in gymnastic performances. . . . There is no part of the organism of man in which the *reconstructive activity* is so great, during the whole period of life, as it is in the ganglionic substance of the brain. This is indicated by the enormous supply of blood which it receives. . . . It is, moreover, a fact of great significance that the nerve-substance is specially distinguished by its *reparative* power. For while injuries of other tissues (such as the muscular) which are distinguished by the *speciality* of their structure and endowments, are repaired by substance of a lower or less specialized type, those of nerve-substance are repaired by a complete reproduction of the normal tissue; as is evidenced in the sensibility of the newly forming skin which is closing over an open wound, or in the recovery of the sensibility of a piece of "transplanted" skin, which has for a time been rendered insensible by the complete interruption of the continuity of its nerves. The most remarkable example of this reproduction, however, is afforded by the results of M. Brown-Séquard's † experiments upon the gradual restoration of the functional activity of the spinal cord after its complete division; which takes place in a way that indicates rather a *reproduction* of the whole or the lower part of the cord and of the nerves proceeding from it, than a mere *reunion* of

Spencer there tries, not only to show how new actions may arise in nervous systems and form new reflex arcs therein, but even how nervous tissue may actually be born by the passage of new waves of isomeric transformation through an originally indifferent mass. I can not help thinking that Mr. Spencer's data, under a great appearance of precision, conceal lamentable vagueness and improbability, and even self-contradiction.

* "Mental Physiology," 1874, pp. 339–345.

† [See, later, Masius in Van Beneden's and Van Bambeke's "Archives de Biologie," vol. i, Liége, 1880.—W. J.]

divided surfaces. This reproduction is but a special manifestation of the reconstructive change which is *always* taking place in the nervous system; it being not less obvious to the eye of reason that the 'waste' occasioned by its functional activity must be constantly repaired by the production of new tissue, than it is to the eye of sense that such reparation supplies an actual *loss* of substance by disease or injury.

"Now, in this constant and active reconstruction of the nervous system, we recognize a most marked conformity to the general plan manifested in the nutrition of the organism as a whole. For, in the first place, it is obvious that there is a tendency to the production of a *determinate type* of structure; which type is often not merely that of the species, but some special modification of it which characterized one or both of the progenitors. But this type is peculiarly liable to modification during the early period of life; in which the functional activity of the nervous system (and particularly of the brain) is extraordinarily great, and the reconstructive process proportionally active. And this modifiability expresses itself in the formation of the mechanism by which those *secondarily automatic* modes of movement come to be established, which, in man, take the place of those that are *congenital* in most of the animals beneath him; and those modes of sense-perception come to be *acquired*, which are elsewhere clearly *instinctive.* For there can be no reasonable doubt that, in both cases, a nervous mechanism is *developed* in the course of this self-education, corresponding with that which the lower animals inherit from their parents. The *plan* of that *rebuilding* process, which is necessary to maintain the integrity of the organism generally, and which goes on with peculiar activity in this portion of it, is thus being incessantly modified; and in this manner all that portion of it which ministers to the *external* life of sense and motion that is shared by man with the animal kingdom at large, becomes at adult age the expression of the habits which the individual has acquired during the period of growth and development. Of these habits, some are common to the race generally, while others are peculiar to the individual; those of the former kind (such as walking erect) being universally acquired, save where physical inability prevents; while for the latter a special training is needed, which is usually the more effective the earlier it is begun—as is remarkably seen in the case of such feats of dexterity as require a conjoint education of the perceptive and of the motor powers. And when thus developed during the period of growth, so as to have become a part of the constitution of the adult, the acquired mechanism is thenceforth maintained in the ordinary course of the nutritive operations, so as to be ready for use when called upon, even after long inaction.

"What is so clearly true of the nervous apparatus of animal life, can scarcely be otherwise than true of that which ministers to the automatic activity of the mind. For, as already shown, the study of psychology has evolved no more certain result than that there are uniformities of mental action, which are so entirely conformable to those of bodily action as to indicate their intimate relation to a 'mechanism of thought and feeling,' acting under the like conditions with that of sense and motion. The psychical principles of *association*, indeed, and the physiological principles of *nutrition*, simply express—the former in terms of mind, the latter in terms of brain—the universally admitted fact that any sequence of mental action which has been frequently repeated tends to perpetuate itself; so that we find ourselves automatically prompted to *think*, *feel*, or *do* what we have been before accustomed to think, feel, or do, under like circumstances, without any consciously formed *purpose*, or anticipation of results. For there is no reason to regard the cerebrum as an exception to the general principle that, while each part of the organism tends to *form itself* in accordance with the mode in which it is habitually exercised, this tendency will be especially strong in the nervous apparatus, in virtue of that *incessant regeneration* which is the very condition of its functional activity. It scarcely, indeed, admits of doubt that every state of ideational consciousness which is either *very strong* or is *habitually repeated*, leaves an organic impression on the cerebrum; in virtue of which that same state may be reproduced at any future time, in respondence to a suggestion fitted to excite it. . . . The 'strength of early association' is a fact so universally recognized, that the expression of it has become proverbial; and this precisely accords with the physiological principle that, during the period of growth and development, the formative activity of the brain will be most amenable to directing influences. It is in this way that what is early 'learned by heart' becomes branded in (as it were) upon the cerebrum; so that its 'traces' are never lost, even though the conscious memory of it may have completely faded out. For, when the organic modification has been once *fixed* in the growing brain, it becomes a part of the normal fabric, and is regularly *maintained* by nutritive substitution; so that it may endure to the end of life, like the scar of a wound."

Dr. Carpenter's phrase, that *our nervous system grows to the modes in which it has been exercised* expresses the philosophy of habit in a nutshell. We may now trace some of the practical applications of the principle to human life.

The first result of it is that *habit simplifies the movements required to achieve a given result, makes them more accurate and diminishes fatigue.*

"The beginner at the piano not only moves his finger up and down in order to depress the key, he moves the whole hand, the forearm, and even the entire body, especially moving its least rigid part, the head, as if he would press down the key with that organ too. Often a contraction of the abdominal muscles occurs as well. Principally, however, the impulse is determined to the motion of the hand and of the single finger. This is, in the first place, because the movement of the finger is the movement *thought of*, and in the second place because its movement and that of the key are the movements we try to *perceive*, along with the results of the latter on the ear. The more often the process is repeated, the easier the movement follows, on account of the increase in permeability of the nerves engaged.

"But the more easily the movement occurs, the slighter is the stimulus required to set it up; and the slighter the stimulus is, the more its effect is confined to the fingers alone.

"Thus, an impulse which originally spread its effects over the whole body, or at least over many of its movable parts, is gradually determined to a single definite organ, in which it effects the contraction of a few limited muscles. In this change the thoughts and perceptions which start the impulse acquire more and more intimate causal relations with a particular group of motor nerves.

"To recur to a simile, at least partially apt, imagine the nervous system to represent a drainage-system, inclining, on the whole, toward certain muscles, but with the escape thither somewhat clogged. Then streams of water will, on the whole, tend most to fill the drains that go toward these muscles and to wash out the escape. In case of a sudden 'flushing,' however, the whole system of channels will fill itself, and the water overflow everywhere before it escapes. But a moderate quantity of water invading the system will flow through the proper escape alone.

"Just so with the piano-player. As soon as his impulse, which has gradually learned to confine itself to single muscles, grows extreme, it overflows into larger muscular regions. He usually plays with his fingers, his body being at rest. But no sooner does he get excited than his whole body becomes 'animated,' and he moves his head and trunk, in particular, as if these also were organs with which he meant to belabor the keys." *

Man is born with a tendency to do more things than he has ready-made arrangements for in his nerve-centers. Most of the performances of other animals are automatic. In him, most of them must be the fruit of painful study. If practice did not make perfect, nor habit economize the expense of nervous and muscular energy, he would therefore be in a sorry plight. As Dr. Maudsley says,† "If an act became no easier after being done several times, if the careful direction of consciousness were necessary to its accomplishment on each occasion, it is evident that the whole activity of a lifetime might be confined to one or two deeds—that no progress could take place in development. A man might be occupied all day in dressing and undressing himself; the attitude of his body would absorb all his attention and energy; the washing of his hands or the fastening of a button

* G. H. Schneider, "Der menschliche Wille," 1882, pp. 417–419 (freely translated). For the drain-simile, cf. Spencer's "Psychology," Part V, chap. viii.

† "Physiology of Mind," p. 155.

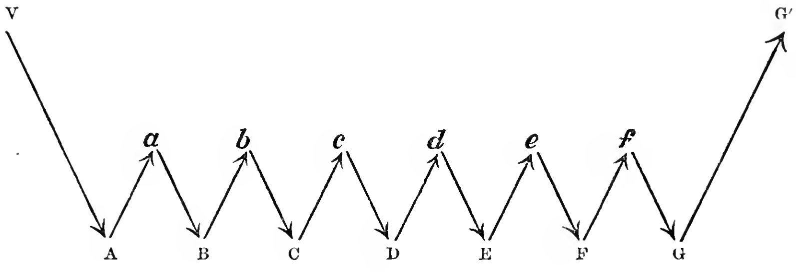
would be as difficult to him on each occasion as to the child on its first trial; and he would, furthermore, be completely exhausted by his exertions. Think of the pains necessary to teach a child to stand, of the many efforts which it must make, and of the ease with which it at last stands, unconscious of any effort. For while secondarily automatic acts are accomplished with comparatively little weariness—in this regard approaching the organic movements, or the original reflex movements—the conscious effort of the will soon produces exhaustion. A spinal cord without . . . memory would simply be an idiotic spinal cord. . . . It is impossible for an individual to realize how much he owes to its automatic agency until disease has impaired its functions."

The next result is that *habit diminishes the conscious attention with which our actions are performed.*

One may state this abstractly thus: If an action require for its execution a chain, A, B, C, D, E, F, G, of successive nervous events; then in the first performances of the action, the conscious will must choose each of these events from a number of wrong alternatives that present themselves as possible; but habit soon brings it about that each event calls up its own appropriate successor without any alternative offering itself, and without any reference to the conscious will, until at last the whole chain, A, B, C, D, E, F, G, rattles itself off as soon as A occurs, just as if A and the rest of the chain were fused into a continuous stream. When we are learning to walk, to ride, to swim, skate, fence, write, play, or sing, we interrupt ourselves at every step by unnecessary movements and false notes. When we are proficients, on the contrary, the results not only follow with the very minimum of muscular action requisite to bring them forth, they also follow from a single instantaneous "cue." The marksman sees the bird, and, before he knows it, he has aimed and shot. A gleam in his adversary's eye, a momentary pressure from his rapier, and the fencer finds that he has instantly made the right parry and return. A glance at the musical hieroglyphics, and the pianist's fingers have rippled through a labyrinth of notes. And not only is it the right thing at the right time that we thus involuntarily do, but the wrong thing also, if it be an habitual thing. Who is there that has never wound up his watch on taking off his waistcoat in the daytime, or taken his latch-key out on arriving at the door-step of a friend? Very absent-minded persons in going to their bedroom to dress for dinner have been known to take off one garment after another and finally to get into bed, merely because that was the habitual issue of the first few movements when performed at a later hour. The writer well remembers how, on revisiting Paris after ten years' absence, and, finding himself in the street in which for one winter he had attended school, he lost himself in a brown study, from which he was awakened by finding himself upon the stairs which led to the apartment in a house many streets away in which he had lived during that earlier time, and to which his steps from the school had then habitually led. We all of us have a definite routine manner of performing certain daily offices connected with the toilet, with the opening and shutting of familiar cupboards, and the like. Our lower centers know the order of these movements, and show their knowledge by their "surprise" if the objects are altered so as to oblige the movement to be made in a different way. But our higher thought-centers know hardly anything about the matter. Few men can tell off-hand which sock, shoe, or trousers-leg they put on first. They must first mentally rehearse the action; and even that is often insufficient—the action must be *performed*. So of the questions, Which valve of my double door opens first? Which way does my door swing? etc. I can not *tell* the answer; yet my *hand* never makes a mistake. No one can *describe* the order in which he brushes his hair or teeth; yet it is likely that the order is a pretty fixed one in all of us.

These results may be expressed as follows:

In actions become habitual, what instigates each new muscular contraction to take place in its appointed order is not a thought or a perception, but the *sensation occasioned by the muscular contraction just finished*. A strictly voluntary action has to be guided by idea, perception, and volition, throughout its course. In a secondarily automatic or habitual action, mere sensation is a sufficient guide, and the upper regions of brain and mind are set comparatively free. A diagram will make the matter clear:



Let A, B, C, D, E, F, G represent an habitual chain of muscular contractions, and let *a, b, c, d, e, f, g* stand for the respective sensations which these contractions excite in us when they are successively performed. Such sensations will usually be in the muscles, skin, or joints of the parts moved, but they may also be effects of the movement upon the eye or ear. Through them, and through them alone, we are made aware whether the contraction has or has not occurred. When the series, A, B, C, D, E, F, G, is being learned, each of these sensations becomes the object of a separate perception by the mind. By it we test each movement, to see if it be right before advancing to the next. We hesitate, compare, choose, revoke, reject, etc., by intellectual means; and the order by which the next movement is discharged is an express order from the ideational centers after this deliberation has been gone through.

In habitual action, on the contrary, the only impulse which the centers of idea or perception need send down, is the initial impulse, the command to *start*. This is represented in the diagram by V ; it may be a thought of the first movement or of the last result, or a mere perception of some of the habitual conditions of the chain, the presence, e. g., of the key-board near the hand. In the present case, no sooner has the conscious thought or volition instigated movement A, than A, through the sensation *a*, of its own occurrence awakens B reflexly ; B then excites C through *b*, and so on till the chain is ended, when the intellect generally takes cognizance of the final result. The process, in fact, resembles the passage of a wave of "peristaltic" motion down the bowels. The intellectual perception at the end is indicated in the diagram by the effect of G being represented, at G′, in the ideational centers above the merely sensational line. The sensational impressions, *a*, *b*, *c*, *d*, *e*, *f*, are all supposed to have their seat below the ideational lines. That our ideational centers, if involved at all by *a*, *b*, *c*, *d*, *e*, *f*, are involved in a minimal degree, is shown by the fact that the attention may be wholly absorbed elsewhere. We may say our prayers, or repeat the alphabet, with our attention far away.

"A musical performer will play a piece which has become familiar by repetition, while carrying on an animated conversation, or while continuously engrossed by some train of deeply interesting thought ; the accustomed sequence of movements being directly prompted by the *sight* of the notes, or by the remembered succession of the *sounds* (if the piece is played from memory), aided in both cases by the guiding sensations derived from the muscles themselves. But, further, a higher degree of the same 'training' (acting on an organism specially fitted to profit by it) enables an accomplished pianist to play a difficult piece of music at sight ; the movements of the hands and fingers following so immediately upon the sight of the notes, that it seems impossible to believe that any but the very shortest and most direct track can be the channel of the nervous communication through which they are called forth. The following curious example of the same class of *acquired aptitudes*, which differ from instincts only in being prompted to action by the will, is furnished by Robert Houdin :

"With a view of cultivating the rapidity of visual and tactile perception, and the precision of respondent movements, which are necessary for success in every kind of prestidigitation, Houdin early practiced the art of juggling with balls in the air ; and having, after a month's practice, become thorough master of the art of keeping up *four* balls at once, he placed a book before him, and, while the balls were in the air, accustomed himself to read without hesitation. 'This,' he says, 'will probably seem to my readers very extraordinary ; but I shall surprise them still more when I say that I have just amused myself with repeating this curious experiment. Though thirty years have elapsed since the time I was writing, and though I have scarcely once touched my balls during that period, I can still manage to read with ease while keeping *three* balls up'" (Autobiography, p. 26).*

We have called *a, b, c, d, e, f,* the antecedents of the successive muscular attractions, by the name of sensations. Some authors seem inclined to deny that they are even this. If not even this, they can only be centripetal nerve-currents, not sufficient to arouse feeling, but sufficient to arouse motor response.† It may be at once admitted that they are not distinct *volitions.* The will, if any will be present, limits itself to a *permission* that they exert their motor effects. Dr. Carpenter writes: "There may still be metaphysicians who maintain that actions which were originally prompted by the will with a distinct intention, and which are still entirely under its control, can never cease to be volitional; and that either an infinitesimally small amount of will is required to sustain them when they have been once set going, or that the will is in a sort of pendulum-like oscillation between the two actions—the maintenance of the train of *thought*, and the maintenance of the train of *movement.* But if only an infinitesimally small amount of will is necessary to sustain them, is not this tantamount to saying that they go on by a force of their own? And does not the experience of the *perfect continuity* of our trains of thought during the performance of movements that have become habitual, entirely negative the hypothesis of oscillation? Besides, if such an oscillation existed, there must be *intervals* in which each action goes on *of itself;* so that its essentially automatic character is virtually admitted. The physiological explanation, that the mechanism of locomotion, as of other habitual movements, *grows to* the mode in which it is early exercised, and that it then works automatically under the general control and direction of the will, can scarcely be put down by any assumption of an hypothetical necessity, which rests only on the basis of ignorance of one side of our composite nature." ‡

But if not distinct acts of will, these immediate antecedents of each movement of the chain are at any rate accompanied by consciousness of some kind. They are *sensations* to which we are *usually inattentive,* but which immediately call our attention if they go *wrong.* Schneider's account of these sensations deserves to be quoted. In the act of walking, he says, even when our attention is entirely off, "we are continuously aware of certain muscular feelings; and we have, moreover, a feeling of certain impulses to keep our equilibrium and to set down one leg after another. It is doubtful whether we could preserve equilibrium if no sensation of our body's attitude were there, and doubtful

* Carpenter's "Mental Physiology," 1874, pp. 217, 218.

† Von Hartmann devotes a chapter of his "Philosophy of the Unconscious" (English translation, vol. i, p. 72) to proving that they must be both *ideas* and *unconscious.*

‡ "Mental Physiology," p. 20.

whether we should advance our leg if we had no sensation of its movement as executed, and not even a minimal feeling of impulse to set it down. Knitting appears altogether mechanical, and the knitter keeps up her knitting even while she reads or is engaged in lively talk. But if we ask her how this be possible, she will hardly reply that the knitting goes on of itself. She will rather say that she has a feeling of it, that she feels in her hands that she knits and how she must knit, and that therefore the movements of knitting are called forth and regulated by the sensations associated therewithal, even when the attention is called away.

"So of every one who practices, apparently automatically, a long familiar handicraft. The smith turning his tongs, as he smites the iron, the carpenter wielding his plane, the lace-maker with her bobbin, the weaver at his loom, all will answer the same question in the same way by saying that they have a feeling of the proper management of the implement in their hands.

"In these cases, the feelings which are conditions of the appropriate acts, are very faint. But none the less are they necessary. Imagine your hands not feeling; your movements could then only be provoked by ideas, and if your ideas were then diverted away, the movements ought to come to a standstill, which is a consequence that seldom occurs." * Again—

"An idea makes you take, for example, a violin into your left hand. But it is not necessary that your idea should remain fixed on the contraction of the muscles of the left hand and fingers, in order that the violin should continue to be held fast and not let fall. The sensations themselves which the holding of the instrument awakens in the hand, since they are associated with the motor impulse of grasping, are sufficient to cause this impulse, which then lasts as long as the feeling itself lasts, or until the impulse is inhibited by the idea of some antagonistic motion." And the same may be said of the manner in which the right hand holds the bow. "It sometimes happens, in beginning these simultaneous combinations, that one movement or impulse will cease, if the consciousness turns particularly toward another, because at the outset the guiding sensations must *all* be strongly *felt*. The bow will perhaps slip from the fingers, because some of the muscles have relaxed. But the slipping is a cause of new sensations starting up in the hand, so that the attention is in a moment brought back to the grasping of the bow.

"The following experiment shows this well: When one begins to play on the violin, to keep him from raising his right elbow in playing a book is placed under his right armpit, which he is ordered to hold fast by keeping the upper arm tight against his body. The muscular feelings, and feelings of contact connected with the book, provoke an impulse to press it tight. But often it happens that the beginner,

* "Der menschliche Wille," pp. 447, 443.

whose attention gets absorbed in the production of the notes, lets drop the book. Later, however, this never happens; the faintest sensations of contact suffice to awaken the impulse to keep it in its place, and the attention may be wholly absorbed by the notes and the fingering with the left hand. *The simultaneous combination of movements is thus in the first instance conditioned by the facility with which, in us alongside of intellectual processes, processes of inattentive feeling may still go on.*" *

This brings us by a very natural transition to the ethical implications of the law of habit. They are numerous and momentous. Dr. Carpenter, from whose "Mental Physiology" we have quoted, has so prominently enforced the principle that our organs grow to the way in which they have been exercised, and dwelt upon its consequences, that his book almost deserves to be called a work of edification, on this account alone. We need make no apology, then, for tracing a few of these consequences ourselves:

"Habit a second nature! Habit is ten times nature," the Duke of Wellington is said to have exclaimed; and the degree to which this is true no one can probably appreciate as well as one who is a veteran soldier himself. The daily drill and the years of discipline end by fashioning a man completely over again, as to most of the possibilities of his conduct. "There is a story, which is credible enough, though it may not be true, of a practical joker, who, seeing a discharged veteran carrying home his dinner, suddenly called out, 'Attention!' whereupon the man instantly brought his hands down, and lost his mutton and potatoes in the gutter. The drill had been thorough, and its effects had become embodied in the man's nervous structure." †

Riderless cavalry-horses, at many a battle, have been seen to come together and go through their customary evolutions at the sound of the bugle-call. Most trained domestic animals, dogs, and oxen, and omnibus- and car-horses, seem to be machines almost pure and simple, undoubtingly, unhesitatingly doing from minute to minute the duties they have been taught, and giving no sign that the possibility of an alternative ever suggests itself to their mind. Men grown old in prison have asked to be readmitted after being once set free. In a railroad accident to a traveling menagerie in the United States some time in 1884, a tiger, whose cage had broken open, is said to have emerged, but presently crept back again, as if too much bewildered by his new responsibilities, so that he was without difficulty secured.

Habit is thus the enormous fly-wheel of society, its most precious conservative agent. It alone is what keeps us all within the bounds of ordinance, and saves the children of fortune from the envious uprisings of the poor. It alone prevents the hardest and most repulsive

* "Der menschliche Wille," p. 439. The last sentence is rather freely translated—the sense is unaltered.

† Huxley's "Elementary Lessons in Physiology," lesson xii.

walks of life from being deserted by those brought up to tread therein. It keeps the fisherman and the deck-hand at sea through the winter; it holds the miner in his darkness, and nails the countryman to his log-cabin and his lonely farm through all the months of snow; it protects us from invasion by the natives of the desert and the frozen zone. It dooms us all to fight out the battle of life upon the lines of our nurture or our early choice, and to make the best of a pursuit that disagrees, because there is no other for which we are fitted, and it is too late to begin again. It keeps different social strata from mixing. Already at the age of twenty-five you see the professional mannerism settling down on the young commercial traveler, on the young doctor, on the young minister, on the young counselor-at-law. You see the little lines of cleavage running through the character, the tricks of thought, the prejudices, the ways of the "shop" in a word, from which the man can by-and-by no more escape than his coat-sleeve can suddenly fall into a new set of folds. On the whole, it is best he should not escape. It is well for the world that in most of us, by the age of thirty, the character has set like plaster, and will never soften again.

If the period between twenty and thirty is the critical one in the formation of intellectual and professional habits, the period below twenty is more important still for the fixing of *personal* habits, properly so called, such as vocalization and pronunciation, gesture, motion, and address. Hardly ever is a language learned after twenty spoken without a foreign accent; hardly ever can a youth transferred to the society of his betters unlearn the nasality and other vices of speech bred in him by the associations of his growing years. Hardly ever, indeed, no matter how much money there be in his pocket, can he even learn to *dress* like a gentleman-born. The merchants offer their wares as eagerly to him as to the veriest "swell," but he simply *can't* buy the right things. An invisible law, as strong as gravitation, keeps him within his orbit, arrayed this year as he was the last; and how his aristocratic acquaintances contrive to get the things they wear, will be for him a mystery till his dying day.

The great thing, then, in all education, is to *make automatic and habitual, as early as possible, as many useful actions as we can,* and to guard against the growing into ways that are likely to be disadvantageous to us, as we should guard against the plague. The more of the details of our daily life we can hand over to the infallible and effortless custody of automatism, the more our higher powers of mind will be set free for their own proper work. There is no more miserable human being than one in whom nothing is habitual but indecision, and for whom the lighting of every cigar, the drinking of every cup, the time of rising and going to bed every day, and the beginning of every bit of work, are subjects of express volitional deliberation. Full half the time of such a man goes to the deciding, or regretting, of matters which ought to have been so thoroughly ingrained in him as practically not to exist for his consciousness at all. If there be such daily duties not yet ingrained in any one of my readers, let him begin this very day to set the matter right.

In Professor Bain's chapter on "The Moral Habits" there are some admirable practical remarks laid down. Two great maxims emerge from his treatment. The first is that in the acquisition of a new habit, or the leaving off of an old one, we must take care to *launch ourselves with as strong and decided an initiative as possible.* Accumulate all the possible circumstances which shall re-enforce the right motives; put yourself assiduously in conditions that encourage the new way; make engagements incompatible with the old; take a public pledge, if the case allows; in short, envelop your resolution with every aid you know. This will give your new beginning such a momentum that the temptation to break down will not occur as soon as it otherwise might; and every day during which a breakdown is postponed adds to the chances of its not occurring at all.

The second maxim is: *Never suffer an exception to occur till the new habit is securely rooted in your life.* Each lapse is like the letting fall of a ball of string which one is carefully winding up; a single slip undoes more than a great many turns will wind again. *Continuity* of training is the great means of making the nervous system act infallibly right. As Professor Bain says: "The peculiarity of the moral habits, contradistinguishing them from the intellectual acquisitions, is the presence of two hostile powers, one to be gradually raised into the ascendant over the other. It is necessary, above all things, in such a situation, never to lose a battle. Every gain on the wrong side undoes the effect of many conquests on the right. The essential precaution, therefore, is so to regulate the two opposing powers, that the one may have a series of uninterrupted successes, until repetition has fortified it to such a degree as to enable it to cope with the opposition, under any circumstances. This is the theoretically best career of mental progress."

The question of "tapering-off," in abandoning such habits as drink and opium-indulgence, comes in here, and is a question about which experts differ within certain limits, and in regard to what may be best for an individual case. In the main, however, all expert opinion would agree that abrupt acquisition of the new habit is the best way, *if there be a real possibility of carrying it out.* We must be careful not to give the will so stiff a task as to insure its defeat at the very outset; but, *provided one can stand it,* a sharp period of suffering, and then a free time, is the best thing to aim at, whether in giving up a habit like that of opium, or in simply changing one's hours of rising or of work. It is surprising how soon a desire will die of inanition if it be *never* fed. "One must first learn, unmoved, looking neither to the right nor left, to walk firmly on the straight and narrow path, before one can begin 'to make one's self over again.' He who every day makes a fresh resolve is like one who, arriving at the edge of the ditch he is to leap, forever stops and returns for a fresh run. Without *unbroken* advance, there is no such thing as *accumulation* of the ethical forces possible, and to make this possible, and to exercise us and habituate us in it is the sovereign blessing of regular *work*."*

A third maxim may be added to the preceding pair: *Seize the very first possible opportunity to act on every resolution you make, and on every emotional prompting you may experience in the direction of the habits you aspire to gain.* It is not in the moment of their forming, but in the moment of their producing *motor effects*, that resolves and aspirations communicate the new "set" to the brain. As the author last quoted remarks: "The actual presence of the practical opportunity alone furnishes the fulcrum upon which the lever can rest, by means of which the moral will may multiply its strength, and raise itself aloft. He who has no solid ground to press against, will never get beyond the stage of empty gesture-making." No matter how full a reservoir of *maxims* one may possess, and no matter how good one's *sentiments* may be, if one have not taken advantage of every concrete opportunity to *act*, one's character may remain entirely unaffected for the better. With mere good intentions, hell is proverbially paved. And this is an obvious consequence of the principles we have laid down. A "character," as J. S. Mill, says, "is a completely fashioned will"; and a will, in the sense in which he means it, is an aggregate of tendencies to act in a firm and prompt and definite way upon all the principal emergencies of life. A tendency to act only becomes effectively ingrained in us in proportion to the uninterrupted frequency with which the actions actually occur, and the brain "grows" to their use. Every time a resolve or a fine glow of feeling evaporates without bearing practical fruit, is worse than a chance lost; it works so as positively to hinder future resolutions and emotions from taking the normal path of discharge. There is no more contemptible type of human character than that of the nerveless sentimentalist and dreamer, who spends his life in a weltering sea of sensibility and emotion, but who never does a manly concrete deed. Rousseau, inflaming all the mothers of France, by his eloquence, to follow Nature and nurse their babies themselves, while he sends his own children to the foundling hospital, is the classical example of what I mean. But every one of us in his measure, whenever, after glowing for an abstractly formulated Good, he practically ignores some actual case, among the squalid "other particulars" of which that same Good lurks disguised, treads straight on Rousseau's path. All Goods are disguised by the vulgarity of their concomitants, in this world; but woe to work-a-day him who can only recognize them when he thinks them in their pure and abstract form! The habit of

* J. Bahnsen, "Beiträge zu Charakterologie," 1867, vol. i, p. 209.

excessive novel-reading and theatre-going will produce true monsters in this line. The weeping of the Russian lady over the fictitious personages in the play, while her coachman is freezing to death on his seat outside, is the sort of thing that everywhere happens on a less glaring scale. Even the habit of excessive indulgence in music, for those who are neither performers themselves nor musically gifted enough to take it in a purely intellectual way, has probably a relaxing effect upon the character. One becomes filled with emotions which habitually pass without prompting to any deed, and so the inertly sentimental condition is kept up. The remedy would be, never to suffer one's self to have an emotion at a concert, without expressing it afterward in *some* active way. Let the expression be the least thing in the world—the giving up of one's seat in a horse-car, if nothing more heroic offers—but let it not fail to take place.

These latter cases make us aware that it is not simply *particular lines* of discharge, but also *general forms* of discharge, that seem to be grooved out by habit in the brain. Just as, if we let our emotions evaporate, they get into a way of evaporating; so there is reason to suppose that if we often flinch from making an effort, before we know it the effort-making capacity will be gone; and that, if we suffer the wandering of our attention, presently it will wander all the time. Attention and effort are, as we shall see later, but two names for the same psychic fact. To what brain-processes they correspond, we do not know. The strongest reason for believing that they do depend on brain-processes at all, and are not pure acts of the spirit, is just this fact, that they seem in some degree subject to the law of habit, which is a material law. As a final practical maxim, relative to these habits of the will, we may, then, offer something like this: *Keep the faculty of effort alive in you by a little gratuitous exercise every day.* That is, be systematically ascetic or heroic in little unnecessary points, do every day or two something for no other reason than that you would rather not do it, so that when the hour of dire need draws nigh, it may find you not unarmed and untrained to stand the test. Asceticism of this sort is like the insurance a man pays on his house and goods. The tax does him no good at the time, and possibly may never bring him in a return. But if the fire *does* come, his having paid it will be his salvation from ruin. So with the man who has daily inured himself to habits of concentrated attention, energetic volition, and self-denial in unnecessary things. He will stand like a tower when everything rocks around him, and when his softer fellow-mortals are winnowed like chaff in the blast.

The physiological study of mental conditions is thus the most powerful ally of hortatory ethics. The hell to be endured hereafter, of which theology tells, is no worse than the hell we make for ourselves in this world by habitually fashioning our characters in the wrong way. Could the young but realize how soon they will become mere walking bundles of habits, they would give more heed to their conduct while in the plastic state. We are spinning our own fates, good or evil, and never to be undone. Every smallest stroke of virtue or of vice leaves its never so little scar. The drunken Rip Van Winkle, in Jefferson's play, excuses himself for every fresh dereliction by saying, "I won't count this time!" Well! he may not count it, and a kind Heaven may not count it; but it is being counted none the less. Down among his nerve-cells and fibers the molecules are counting it, registering and storing it up to be used against him when the next temptaton comes. Nothing we ever do is, in strict scientific literalness, wiped out. Of course, this has its good side as well as its bad one. As we become permanent drunkards by so many separate drinks, so we become saints in the moral, and authorities and experts in the practical and scientific spheres, by so many separate acts and hours of work. Let no youth have any anxiety about the upshot of his education, whatever the line of it may be. If he keep faithfully busy each hour of the working-day, he may safely leave the final result to itself. He can with perfect certainty count on waking up some fine morning, to find himself one of the competent ones of his generation, in whatever pursuit he may have singled out. Silently, between all the details of his business, the *power of judging* in all that class of matter will have built itself up within him as a possession that will never pass away. Young people should know this truth in advance. The ignorance of it has probably engendered more discouragement and faint-heartedness in youths embarking on arduous careers than all other causes put together.

SCIENCE IN RELIGIOUS EDUCATION.

By DANIEL GREENLEAF THOMPSON.

II.

[*Concluded.*]

LET us now turn our attention to those higher seminaries of learning, which, though often assisted by public funds, or patronized in one way or another by the state, are not exclusively state institutions. Wherever a college or university happens to be under state control, precisely the same principles should obtain regarding the teaching of religion as we have found applicable in the case of inferior schools. Indeed, whether the institution be public or private, these principles equally apply, but there are some differences in situation of which we must take note.

Undoubtedly a religious organization has and should have the right to found and maintain schools to educate the young into its beliefs. Most of the New England colleges were established primarily to train young men for the Christian ministry, and in nearly all of them the promotion of the Christian religion (by which is meant the so-called evangelical religion) is the first object. As subsidiary to this come science, languages, and *belles-lettres* generally. Upon this basis, indeed, the greater part of the collegiate institutions in England and America stand to-day. With respect to all such, then, the question is, whether they are to be approved and supported; and, if not, what should be done to change their character so as to counteract whatever is unfortunate or baneful in their influences.

An ideal of education which sets up the attainment of truth before everything else, and claims not only the right but the necessity of questioning all things and proving all things, never can be satisfied with the constitution of any college or university whose first end and purpose is to promote any religion whatever, be it Christian, Mohammedan, Confucian, or Buddhistic. A theological seminary to be entered after general education, may properly be sectarian and be maintained for the special purpose of teaching any kind of dogma that its founders and patrons desire taught. Not so, however, with an institution for general academic instruction and study. And it must not be overlooked that an institution whose chief aim is "to promote the religion of Christ," though apparently this would include many sects, is, after all, necessarily sectarian and partisan. To begin with, it is sectarian, because, since there are many Christian sects and a great variety of Christian doctrines, some form of this doctrine must be selected and favored, if "promotion" be the chief object. Any organization for convincing and persuading must have something respecting which it is to convince and persuade. It thus can not avoid being sectarian, if it preserves any character as an effective promoting force. Such we find actually to be the case. Either by agreement at the outset or by a process of natural selection, colleges and seminaries whose chief aim is to promote the religion of Christ become inevitably Roman Catholic, Episcopalian, Baptist, Methodist, Presbyterian, Congregationalist, or something else, according to circumstances. However liberal they may be in selecting teachers for other departments, the religious teaching is all of a kind, just in the measure that they make the advancement of religion an object. Thus, though college authorities declare in their prospectus, for the purpose of attracting students, that their teaching is not sectarian, a person who reflects on the subject will not be deceived. It must be sectarian, so far as it is aggressively religious, although it may be very tolerant of all sects whose tenets are like its own. If the dominant sect differs from another only on the question of the mode of baptism, no very great amount of disfavor toward the latter would be discovered. But let the point of difference be the divinity of Christ, or the question of eternal punishment, and we shall soon see developed the strength of sectarian feeling in a manner sufficient to remove all doubts.

Even if there were unity of belief in Christianity, the existence of other religions in the world, supported by millions of people, is of itself sufficient to make the man who loves truth above all things demand for higher educational institutions something more truly catholic for an aim than the promotion of any one religion. If the highest truth be coincident with Christian doctrine ; then, if truth in itself be made the chief end, the only result is to advance Christianity also, while there is no possible ground of reproach on the score of sectarianism. Such a reproach is not alone liable to come from atheists and agnostics, who may be considered possibly to have no rights which Christians are bound to respect. There happens to be in Christian communities a large class of people of the highest degree of enlightenment to whom the central doctrines of Christianity are repugnant, and who are devoted to a religion of their own—the religion, indeed, out of which Christianity sprang, but a religion which does not recognize any divine character in Jesus of Nazareth or any divine mission in his career. Such people are not atheists or agnostics. They worship the same God as the Christians do ; and they adopt as a sacred book more than half the Christian Bible. In former times Christians used to treat them with the greatest contumely, scarcely as human beings, in fact ; in some parts of the world to-day they are persecuted. But in countries where equality before the law is the rule, they have the same rights as other people ; and their religious views ought to be recognized in those institutions to which they contribute. The existence of a large number of believers in the Jewish religion is certainly an additional argument against dogmatic religious teaching in any seminary of learning which seeks or obtains state aid. It is also conclusive against the claim that to promote Christianity is not a sectarian aim, for by the expression not alone practical or humanitarian, but doctrinal or theological Christianity is always intended.

Yet this contention that they are in no wise sectarian or partisan continues to he made by distinctively Christian colleges. Under this declaration, they open their doors to the world and profess to give the youth all the higher instruction he needs. They claim to teach knowledge, science, truth. But they certainly would not allow anything to be truth which militates against Christianity as an exclusive religion, as the only hope for mankind—this hope lying not in the spirit of altruism pervading Christianity but in loyalty to Jesus Christ personally as the sole Redeemer and Saviour. The Jewish view of Jesus would not be tolerated for an instant ; the Unitarian belief is not less obnoxious ; the agnostic humility is thought blasphemous. The possibility of the "orthodox" principles and facts being error is not to be allowed or considered ! The chief business of these institutions is to maintain the truth of their religious creed as a postulate not to be questioned, as an assumed point of departure for all acquisition of knowledge, and as the supreme end of all learning. For instance, President Adams, of

Cornell University (1886), declares that the university "must always be on the side of Christianity as opposed to infidelity or unbelief." President Seelye, of Amherst College, declares in his inaugural (1877) that the college must be solicitous, "first of all, to continue Christian." "It will seek for Christian teachers and only these." On these principles, "it will order all its studies and its discipline." It is, then, idle to say that such institutions will teach science or truth, except as science and truth are in accord with "evangelical" Christian theology. Everything else is necessarily untruth, unreason, error. Said President Witherspoon, of Princeton: "Cursed be all that learning that is contrary to the cross of Christ; cursed be all that learning that is not coincident with the cross of Christ; cursed be all that learning that is not subservient to the cross of Christ!"

While there must be liberty to establish denominational and sectarian colleges to "promote" religion; and if, while there are such, it is the best public policy to have as great a variety of beliefs represented as may be possible, in order to insure healthful counteraction, this condition of things does not fulfill the demands of a scientific educational system. When we send our young men and women to learn geometry or natural philosophy, it is geometry and natural philosophy as sciences, as matters of knowledge, truth, that we wish them taught; not Presbyterian or Episcopalian or Methodist geometry or physics. There are church schools where church creeds are inculcated, and in these the youth can learn the things that belong to their particular sect. Or, if it be desirable to have such teaching in the same school which teaches geometry, there is no serious objection to a professorship of the soundest kind of the special orthodoxy desired, so long as the opposite kind of orthodoxy is not denied similar privileges. By keeping the professorship of geometry or biology unfettered by any complications with the professorship of Presbyterian theology, both biology and Presbyterianism might be learned in the same college. Then the qualification for a teacher of biology would be that he knows biology, and his religious belief would be irrelevant. As it is, whenever we examine college catalogues we discover the title "Reverend" prefixed to the names of most of the professors, even of languages and science. This creates a suspicion which is confirmed absolutely when we find, as we do in many colleges, that no one who is not a professing Christian is eligible to the position of teacher! Charles Darwin would not have been "fit" to teach biology; nor would Huxley be fit to teach natural history, nor Tyndall to give instruction in physics! Institutions like these may be provisionally endurable; but they do not satisfy the highest ideals either of truth or morality. Unless the policy of the fagot should return and become successful once more, they must be superseded by something better.

The effort ought to be made, therefore, to establish and maintain a larger number of colleges and universities which shall be absolutely without any religious *purpose* or aim, but which shall furnish facilities to the student for obtaining instruction in the comparative study of religions, and in the tenets of the leading religious sects, such instruction to be critical, not authoritative. These universities should be broad enough to cover all branches of science, including religions, and each department should stand upon its own foundation. The teacher of Latin should be qualified by reason of his knowledge of Latin and ability to communicate it, and it should matter not whether he be a Christian. The government of the institution should be wholly impartial as regards religion, and its charter ought to forbid religious discrimination in any form. As to worship, the teaching of religion by insinuation, that should have no place in a university save as a matter of voluntary attention. Of a college church there can be no need ; for in any college-town there are, no doubt, ample opportunities for the enjoyment of religious services among the churches of the neighborhood.

Such a scheme of collegiate institutions has commended itself to a great many thinking people, but the importance of creating and sustaining the like should be more sensibly appreciated. The Christian church has always been alive to the value of education for the promotion of its own interests. The monks were usually men of peace, but, through their care for the instruction of youth, they became more powerful than the men of war. Though they were working chiefly to perpetuate the power of their order, the world is greatly indebted to them for the preservation of learning and the interest in its acquisition. It is true enough that the church has been in times past the foster-mother of education, but it is not true, therefore, that education will not flourish except under the auspices of religious organization. Let it be impressed upon the community that for the preservation of the social organism education is necessary, for the life that now is ; for good government and a larger liberty, and just as powerful a motive is created to promote it as any that loyalty to an ecclesiastical society can originate. To encourage this thought, and to secure its practical carrying out, should be the aim of those who believe in a stable social order; who appreciate, indeed, the value of knowledge in religious matters so well that they are not willing to rest content with partial truth and error. Some institutions of learning there are that foster such a sentiment, and which in their constitution are substantially free from religious partisanship ; it is desirable to have more.

Modifying influences are everywhere at work upon existing colleges and universities, and they are nearly all in some degree susceptible of improvement in the directions I have indicated. They desire students and must have funds. The best method of making them understand their short-comings is to cut off their supplies of both. But the higher education must be had, and if it can not be obtained in a non-sectarian institution, the conditions are often such that with proper antidotes the sectarianism inculcated may not do much harm. It is a significant fact that in some of the American colleges, founded to train young men for the Christian ministry, a very small and continually decreasing number of graduates embrace that profession. Emotional revivals are growing less in favor and are of less influence. The strong tendency of public sentiment, at least among the patrons of colleges, is toward the abolition of compulsory worship, and this has been effected in the largest American university. Thus, it may be said that there has been in America a progressive secularisation of colleges, spite of the resistance offered by their boards of government. The university systems of Continental Europe already allow much greater freedom from coercive influences of religious creeds. The American college system must give way to the broader plan exemplified in Germany, and to some extent in England, and proceed still further in the direction of making religious instruction only a department on equal footing with other departments. Those who are interested in existing collegiate schools, and who esteem it to be a higher, nobler, more truly religious ideal of education, that truth, verified knowledge, be sought persistently, and be inculcated regardless of its consequences upon a religious system maintained by authority, should not rest until the narrower object of promoting any religion ceases to be the chief end and aim toward which all the teaching in the institution converges.

This result can scarcely be brought about so long as the government and instruction in such institutions is confided in a controlling degree to clergymen. Now in this class there are, of course, many learned, catholic, truth-loving men ; but the trouble is, they are all under retainers and have necessarily a professional duty which they must first perform. Doubtless they have in each case espoused a cause in which they fully believe ; but their opinion, upon any point which touches the interests of their churches or their church, is of no more value as regards truth than the statements before the court of counsel in a law case. It is to be hoped that falsehood will not be practiced or countenanced either by the clerical or the legal advocate ; in both instances what is said is probably believed to be true ; but the mind of each is necessarily shut to anything that militates against the party for whom he appears, except for the purpose of refutation. It would not be just to allow one of the attorneys in an action at law to decide the case. This is what we are doing, however, when we put clergymen in control of educational institutions. As judges of truth, they are not "fit" to pass upon any question which concerns the welfare of their respective religious systems. They are disqualified by reason of interest. But such judges we need in our schools and colleges. If it were not for religious bias and intolerance we might have them ; if the scientific method of instruction in religion were adopted, we certainly should have them. But until such a happy day arrives, so long as we must have advocates without judges we shall get at truth much faster and with greater certainty if at least we hear both sides. Let clergymen be appointed to professorships relating to their calling. Then they are in their place. Let them also be represented in boards of government; but to give them any longer the controlling power either in faculty or among trustees, or in the presidential office, is to interpose the most effectual means to arrest progress in higher education, to defeat the healthy growth of intelligence, and to dwarf and shrivel the characters of the students, who ought to receive from such institutions a thoroughly enlarging and ennobling influence.

If this seems ungracious, as doubtless it will to some, it must be insisted, with courtesy, indeed, but with firmness, that a necessity exists for reducing the too extravagant claims of the clerical profession to authority by reason of their office. They consider that their position, as representatives of a higher power than man, makes their anger righteous, and renders opposition to their declarations impious. Hence they attack with great vigor and often vituperation, but, if the objects of their wrath turn in self-defense, the rain of anathemas is increased tenfold ; and should it happen that they are worsted in the conflict, they begin to cry out that they are persecuted! Now, patience is a virtue, and ought to be exercised ; it is the weak rather than the strong who are intolerant ; but surely people who claim more than they are entitled to must not expect that their claims will be recognized. Much less, when their demands for respect involve the stoppage of progress in knowledge and inquiry, can they reasonably anticipate acquiescence. Clergymen often complain of the increasing lack of deference shown to their order by the laity, while they bitterly lament their very conspicuous loss of influence. Reflection, however, ought to make the causes plain to them. The simple truth is, that they have latterly been growing to be of less value to the community. Many, indeed, are most excellent and useful members of society, and such do not fail of receiving full recognition. But, on the other hand, many are obstructionists to the advancement of civilization. And it must be said, also, that far too many are substantially paupers. They are supported by the community's earnings, and give nothing in return. They do not even express thankfulness for what they receive. If offered a crust of bread, they cry out for the best the table affords, and threaten the good housewife if they do not get it. Until they become moral and intellectual producers, they have no right to consume. If, therefore, when they are rebuked, they think those who rebuke them to be arrogant, in justice they must be plainly reminded of their situation. Clergymen must neither ask immunity from criticism because they are clergymen, nor must they expect to dominate the educational sphere through any "inherent sacredness" of their profession. If they attack, they must not complain if they are attacked. If they think more highly of themselves than they ought to think, they must not feel aggrieved if they sometimes find their pretensions ignored or treated with contempt. The gist of this whole matter is, that the doctrine of inherent authority in any statement, principle, profession, or office must be abandoned.

Where we find the position taken that anything or anybody must not be questioned or criticised, we may be sure that then ignorance, error, or oppression exists, as latent if not patent evil.

It will be a great pity if religious men and women misapprehend the meaning of modern scientific criticism of Christian doctrine and of religious organization. If they did but know it, the salvation of present organized religion depends upon this criticism. The most serious question which weighs upon the thought of earnest men who are lovers of their kind is, how to save the good which there is in Christianity and perpetuate it for the human race. The edifice is at present in danger of ruin, through the folly of its guardians. No one can deny the service which Christianity has rendered ; but people will not see what it is in Christianity which has brought about the benefit. It is the altruistic element which, affecting character, has caused men to seek growth through assimilation, instead of pushing their way in the world by mechanical impact. It is the encouragement to natural development produced by Christianity, and by other causes as well, which has worked the change in humanity. It is the ideal of human perfection, and of organic connection in society as the only way to realize that ideal, which has given its glory to the Christian system. It is the general doctrine and the special dogmas of authority which have constantly interfered with and nullified its beneficent tendencies. It may be that, in days gone by, the supernatural machinery, the stringent ecclesiastical organization was necessary, to keep alive the Christian, humanitarian spirit ; for, in past times, force and fear ruled, and nothing could be sustained without physical power behind it. The present situation, when an industrial civilization is superseding the militant, is altogether different. It is no longer possible for religious authority to sustain itself ; its day has gone by. The clergy do not see this ; they will not recognize environing conditions. They can not be made to understand that what was good is now passing to better, and that the soul of things is, after all, sweet. They sorrow and are angered ; but their hell is really of their own making. Upon the world the blessed light of a new and a more perfect day is dawning. They must either flee away with the darkness, or they must let the light penetrate their souls. If they will allow the latter, they will behold a much more glorious vision of Beauty, Truth and Goodness, the three sisters "never to be sundered without tears." The good in Christianity will not die, though errors be found, acknowledged, and discarded. Religion will not pass away, because it is inbred in the human mental constitution. The men who are accused of seeking to destroy Christianity are its best friends. There is not a Christian church which may not stand, increase its membership, and become a much more active power for good, if only it will abandon its superstitions. The clergy say that to do this is to abandon Christianity. A great many of the laity do not think so. That is the issue. In the absence of some effective counsel of reconciliation, more destructive work will have to be done. Meanwhile, I cordially invite the clergy to become scientists. If existing religious organizations are to be preserved, the scientific method must be unqualifiedly adopted and prosecuted in the study and teaching of religion. By this method, ecclesiasticism may be transformed, and organized religion saved. Without it, deterioration will go on till the ruin is complete. If the present system of organized Christianity perish, however, the men who are responsible for its destruction will be those officially in charge of its interests; who might have saved it if they would, but were not wise in time; who would not believe in the power of social forces; who refused to perceive the necessity of adaptation, the certainty and the beneficence of change; who had not faith in the God of their worship, as he works in and through Nature; and who would not allow their own minds to awake from their dead selves and rise "to nobler verities."

To conclude, now, these remarks upon religious education, let me sum up what I conceive to be the scientific position. Religious truth should be taught in schools and seminaries of learning as far as it is a matter of scientific knowledge, but critically and not with the purpose of promoting any religion. The utmost care should be taken to present arguments for and against any statement of fact, or any inference, judicially and without the arts of persuasion. Doubt and inquiry should be favored and stimulated, not discouraged or repressed. If this can be accomplished, it is desirable to have religion, as something to be studied in its relations to truth, to character and conduct, taught in public and other schools. But if this method can not be followed, then, until there is unanimity of opinion as to what is true in religion, all teaching on the subject must be excluded from the public schools. In other institutions effort should be made to introduce and develop the scientific, the critical, the comparative method in this sort of instruction, while every encouragement should be given also to the establishment of schools, colleges, and universities, where its adoption and consistent practice shall be insured.

THE SOUTH-AFRICAN DIAMOND-MINES.

IT was a pleasant fancy of a writer in the "Cornhill Magazine," to argue for the plausibility of the fairy-story of the princess from whose pretty lips "fell diamonds, both in speaking and in singing, and even in silence," when she merely smiled. "For, consider," he says, "into what does the diamond blaze, when, on combustion, the spirit of the gem leaps upward home again to its parent, the sun; into what but carbonic-acid gas?—that *carbon dioxide* of the chemist which attends the combustion of every fire- and gas-burner, the decomposition of every vegetable, which is exhaled in every breath we breathe?" The same writer also utters the less pleasing but equally striking thought that "the chimney-sweep is covered by that which, under happier auspices, would be jewels."

The diamond is mentioned very anciently in literature. Jupiter, according to classical mythology, was anxious to make men forget the days he had spent among them, and finding that one man—Diamond of Crete—remembered him, turned him into a stone: not a very credible story of the origin of the gem, but men of science in the nineteenth century are not much nearer to knowing the truth on the subject. The Greeks call the stone *adamas* (ἀδάμας) the indomptable or unchangeable; and from this has come down our word *adamantine* and, after the letters have undergone changes of a kind that are not rare in the growth of language, our name of the stone itself. But, long before the Greeks had emerged from the darkness of the mythic age, the diamond was made, among the Hebrews, the peculiar jewel of the tribe of Zebulon; and Aaron's breastplate, when he was dressed in his priestly robes, was adorned in the second of the four rows of its setting with precious stones—with an emerald, a sapphire, and a diamond; and Jeremiah, when the Greeks were just beginning to be known, rebuking the misgoings of his people, said, "The sin of Judah is written with a pen of iron, and with the point of a diamond."

But, although the ancients considered the diamond indestructible, and were capable of trying the most daring experiments with it, no specimen that is known to have belonged to them has come down to us. Some persons suppose that the Koh-i-nor is five thousand years old, as man's possession, but no one knows or can trace its history back with certainty for more than a few centuries.

The diamond has been found in widely separated parts of the world. Among these, Central India, Sumatra, Borneo, the Ural Mountains, California, Brazil, the Cape of Good Hope, and China have been named, in their several times, as principal localities, while it might be hard to enumerate all the minor sites. The Greeks said it was found in Ethiopia. The Indian mines are certainly of very high antiquity, for the stones are mentioned in the "Mahabaratta," and the Romans obtained their supplies chiefly from the mines of Jumalpoor, in Bengal. The Indian mines are scattered along the center of the peninsula, through 10° of latitude, from near the southern bank of the Ganges in latitude 25° to latitude 15° in the Madras Presidency. The most famous ones were those of Golconda, in the Nizam's territory, which were called after the city and fort of that name, where was the market to which they were brought, although none of them were found there or in the near neighborhood. Nothing of the city is left, and the mines have fallen into neglect ; but when Tavernier visited the district, in 1636, he found twenty-three mines in operation, employing sixty thousand men and women, girls and boys, and producing some wonderfully large and fine stones.

The mining district between the Godavery and the Mahanadi—the Adamas River of the ancients, where, it was said, "They find diamonds in quantities "—was also visited by Tavernier in 1655. The whole population were then accustomed to explore the river-bed in the late winter, when the water was low, and there was no work in the fields, and wash the diamonds from the sand.

The only mines in India now worked are at Pannah—the Panossa of Ptolemy—in Bundelcund. These also were in their day the most important diamond-fields in the world ; now they are let by the local ruler to native workers, who put on an air of deep poverty, and whose greatest trouble arises from the fear that their lord may think they are becoming prosperous, and increase his charges upon them. They excuse their listlessness by averring that the tutelary deities of the soil, being irritated by the English conquest, have deserted the mines and ceased to plant them with precious stones. The rajah, however, expects at least a minimum of revenue from his mines, for, we are told, if it falls below a fixed sum, he beheads a chief and confiscates his goods. "He is cheated all the same, but he gets an actual share of one kind or another, which, without the making of an occasional example, would doubtless be denied him." The diamond industry of this country, whence nearly all the most famous crown-jewels of Europe were derived, which was once so prolific that the very mention of the name of India still awakens in the imaginative visions of untold wealth and glittering splendor, has fallen off till it is now estimated that the whole weight of Indian diamonds exported to Europe is not greater than one hundred carats a year. It was practically extinguished by the opening up of the mines of Brazil, which were discovered in 1725, and began to send in their consignments in 1730.

The first Brazilian diamonds were found by the gold-washers in the Villa do Principe, who used the crystals for counters in playing cards. A monk, who had been in India, recognized them as diamonds, and sent some of them to Europe to be cut, and thereby advertised their existence. In 1730 the diamond-fields were declared to be royal property ; and from that time on, till diamonds were found in South Africa, Diamantina, in Minas-Geraes, Matto-Grosso, and the mines of the Paraguay River, were the chief sources of the world's supply. Another diamond-field was discovered in 1843, in the province of Bahia, which soon became the center of a population of thousands of seekers, and for a time yielded rich returns.

Of other famous diamond-fields—Madame Meunier records that the Chinamen in the mountains of Chinkangling collect diamonds from the sands in the valleys by wearing slippers of straw which catch the precious stones and hold them, and then, on being burned, give them up. Diamonds in considerable quantities have been mined in Borneo, which has furnished one of the largest gems in the world, valued by the Governor of Batavia, who made the offer to the owner to be refused, at the worth of two brigs of war fully equipped and ammunitioned, plus one hundred and sixty thousand dollars. Some specimens have been found in Australia, which might have attracted more attention but for the discovery of the South-African fields, and small numbers or small crystals in nearly every other country.

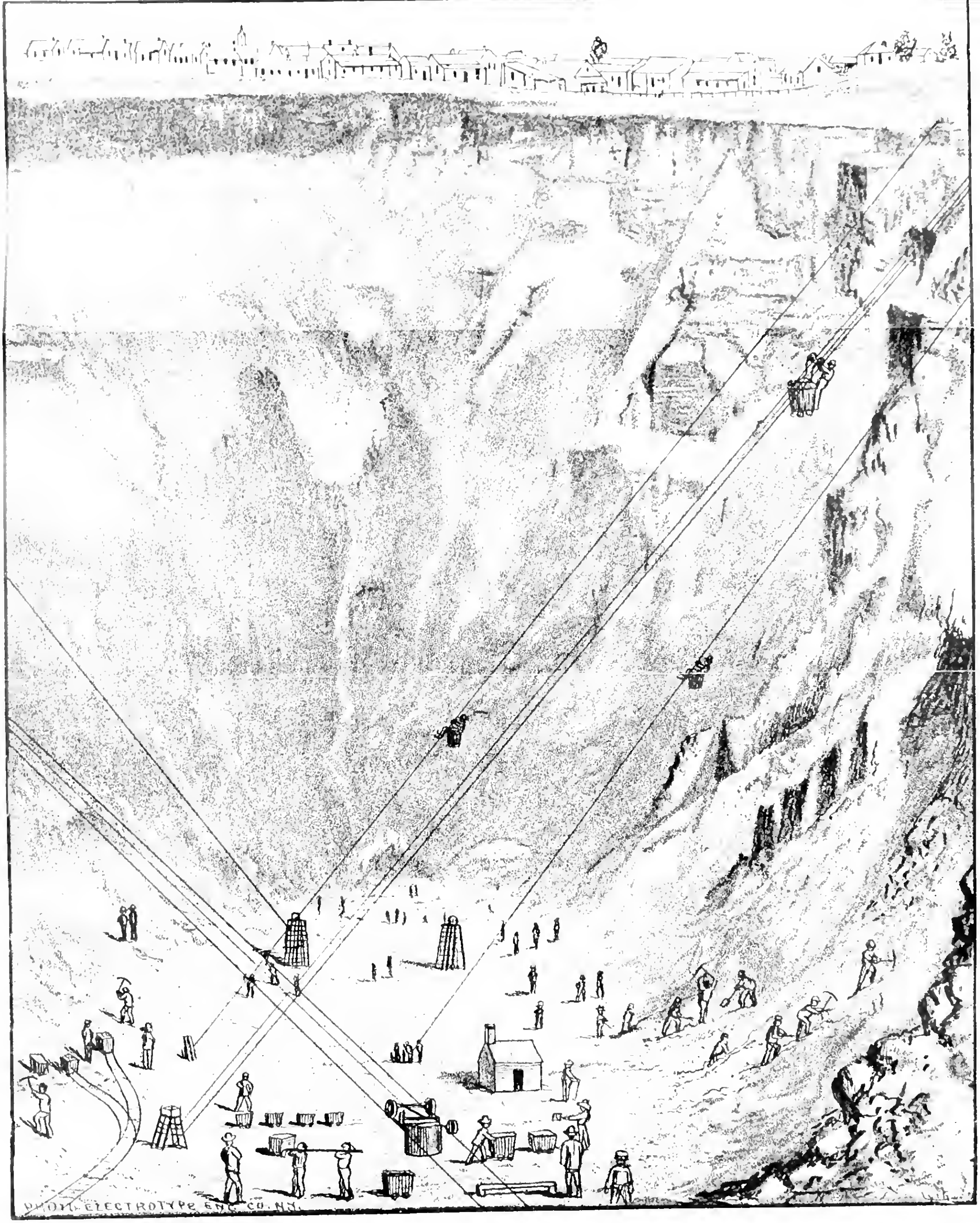
The diamond-fields of South Africa are richer and more extensive than any others—so far as we know of present and have accounts of past richness—although they were only discovered less than twenty years ago. They are situated in Griqualand West, north of the Orange River, at an elevation of four thousand feet above the sea, six hundred and ten miles from Cape Town, and four hundred and eighty miles from Port Elizabeth. They might have been found long before they were, for the place was marked on a French mission-map of 1750 with the phrase "*Ici sont des diamants*" ("Here there are diamonds"), but that had long been lost sight of or disregarded. The rivers of the region had been resorted to by the natives and their ancestors for perhaps generations, for crystals with which to bore their weighting-stones, but no account seems to have been taken of that fact. Van Niekerk's children at Barkly, on the Vaal, and De Beer's at Dutoitspan, were in the habit of playing with the diamonds along with the other pretty pebbles which they found in the gravel, and no one thought the diamonds were anything more than pretty stones till one evening in March, 1867, when a trader, John O'Reilly, "outspanned" at Mr. Niekerk's farm. "O'Reilly saw a beautiful lot of Orange River stones on the table, and examined them. 'I told Niekerk,' he says, 'they were very pretty. He showed me another lot, out of which I at once picked the first diamond. I asked him for it, and he told me I could have it, as it belonged to a Bushman boy of Daniel Jacob's. I took it at once to Hope Town, and made Mr. Chalmers, civil commissioner, aware of the discovery. I then took it on to Colesberg, and gave it to the acting civil commissioner there, for transmission to Cape Town to the high commissioner.'" Another account says that O'Reilly and Niekerk tried the stone on the window, and scratched the glass with scratches that are still there; and that on his way, O'Reilly was laughed at for believing that he had a diamond, and the stone was taken from him and thrown into the street, whence he had some difficulty in recovering it. This stone was sold to Sir Philip Wodehouse, for £500. Several other diamonds were obtained during the year, among them the famous "Star of South Africa," which was bought of a native for £400, and sold in Hope Town for more than £10,000; and now, cut, reduced from 83½ carats in the rough to 46½ carats, and in the jewel-case of the Countess of Dudley, is valued at £25,000. Upon the news that such a gem as this had been found, which was spread in 1869, a "rush" of diggers took place to the Orange River. It was on the Vaal, however, that they found the diamonds, and they scattered their camps for a hundred miles or so along its course, where the washings still yield more or less satisfactory returns. The importance of this district was destined to be speedily eclipsed by the discovery, in 1871, of the famous Kimberley mine—first known as the "Colesberg Kopje," or Colesberg Hill, because it was discovered by three men from Colesberg, afterward by the suggestive name of "De Beer's New Rush," and finally by its present title—and its companion mines De Beer's, Bultfontein, and Dutoitspan. These mines are situated some twenty miles south of the river-mines, in a sandy, treeless country, that contrasts most unfavorably with the green and shady valley of the Vaal, and are so placed with reference to one another that a circle three and a half miles in diameter will inclose them all.

The Kimberley mine was opened to the public on the 21st of July, 1871, the allotments being made in claims thirty-one feet square. Any one could take one or two claims, but no more, for himself, on the payment of thirty shillings a month. If the claim remained unworked for a month, it could be allotted to another applicant on the same terms. A strip of seven and a half feet on one side of each claim was reserved for roadways, of which some fourteen or fifteen, each fifteen feet wide, were provided. But as the claims were worked, forming pits of greater and greater depth, the roadways soon became unsafe and began to cave in, and they eventually had to be abandoned. But the scene while they were in operation is described by Mr. Theodore Reunert, in the "Hand-Book" of the colony, which was published in connection with the recent Indian and Colonial Exhibition, as having been most picturesque: "Hundreds of carts and wheelbarrows careering along the roads, bearing their precious freight of excavated ground clear of the mine to be sorted; down below, at all distances from the surface, a succession of rectangular ledges, representing the various working-levels of different claims, where thousands of diggers and native laborers, crowded together on the narrow working-spaces, were busy picking and shoveling the ground and filling it into the original tubs and buckets of all sorts and sizes employed for conveying it to the surface; some of these were hauled up by ropes and tackle, others carried by hand up inclined planks and staircases cut in the perpendicular walls; each man worked on his own device, without regard to his neighbor, the only general rule being that the roadways must be kept intact."

After the roadways collapsed, the problem was presented of finding a way to work the large number of successive holdings, so as to preserve free access to each, and still let no claim-holder encroach or trespass on his neighbor's ground. A system of haulage upon endless ropes stretched between the claims and the edge of the mine, was adopted as a temporary expedient; but this had to yield to the objections that the entire circumference of the mine did not afford frontage enough for the erection of a hauling-gear to each claim; and even if it had been enough, difficulties would have to be encountered in the crossing of the ropes. These difficulties were remedied by the erection of a system of stagings around the margin of the mine, having four or five stories of scaffolds, on which the endless ropes could be landed at different levels, the highest platforms communicating with the claims nearest the center of the mine. This arrangement gave way in time to "horse-whims," and then to steam-engines, the introduction of which was long delayed on account of the cost of transit over the five hundred miles from the coast, and of the uncertainty which prevailed whether the mines would hold out long enough to make the expenditure for them profitable.

The four principal diamond-mines of the Kimberley district have substantially the same formation. They are like bowls of diamond-bearing earth lying in a funnel-shaped inclosure of unknown depth. The surface of the whole country is covered with red, sandy soil, varying from a few inches to about two feet in depth; underneath this is a thin layer of calcareous tufa, never extending beyond a few feet in thickness. Both of these layers are of recent date, or even still in course of formation, and are general. Beneath them, the distinction between the mine formation proper and the outside rocks or "reef," first becomes apparent. The next general formation going down, in which the diamond-bearing funnel is hollowed out—the "reef" of the miners—is a shale, yellow, or colored from gray to pink, the "upper reef" extending to a depth of from thirty-five to fifty feet, beneath which is a black carbonaceous shale, running to from two hundred and sixty to two hundred and eighty-five feet below the red sand, where it gives place to an amygdaloid dolerite, identical with the bed-rock at the Vaal River diggings.

The diamond-bearing soil is, for the first hundred feet down, soft and friable, of a yellowish color, and crumbling as soon as it is exposed to the air. At about this level, although there were variations in the depth on different claims, the character of the rock all at once changed, and it became hard and of a slate-blue color. This feature caused a panic among the miners, for they at once presumed that the bottom of the diamond-deposit had been reached. They, however, treated the matter in a business sort of way, as things are said to be done in the exchanges where speculation rages. According to the story, as told by Mr. George J. Nathan, in "Longman's Magazine," "the claim-holders determined to say nothing about their discovery, but to go at once and try to sell their claims to unsuspecting diggers. Several of them accordingly put back the diamondiferous soil to the depth of a few feet, and



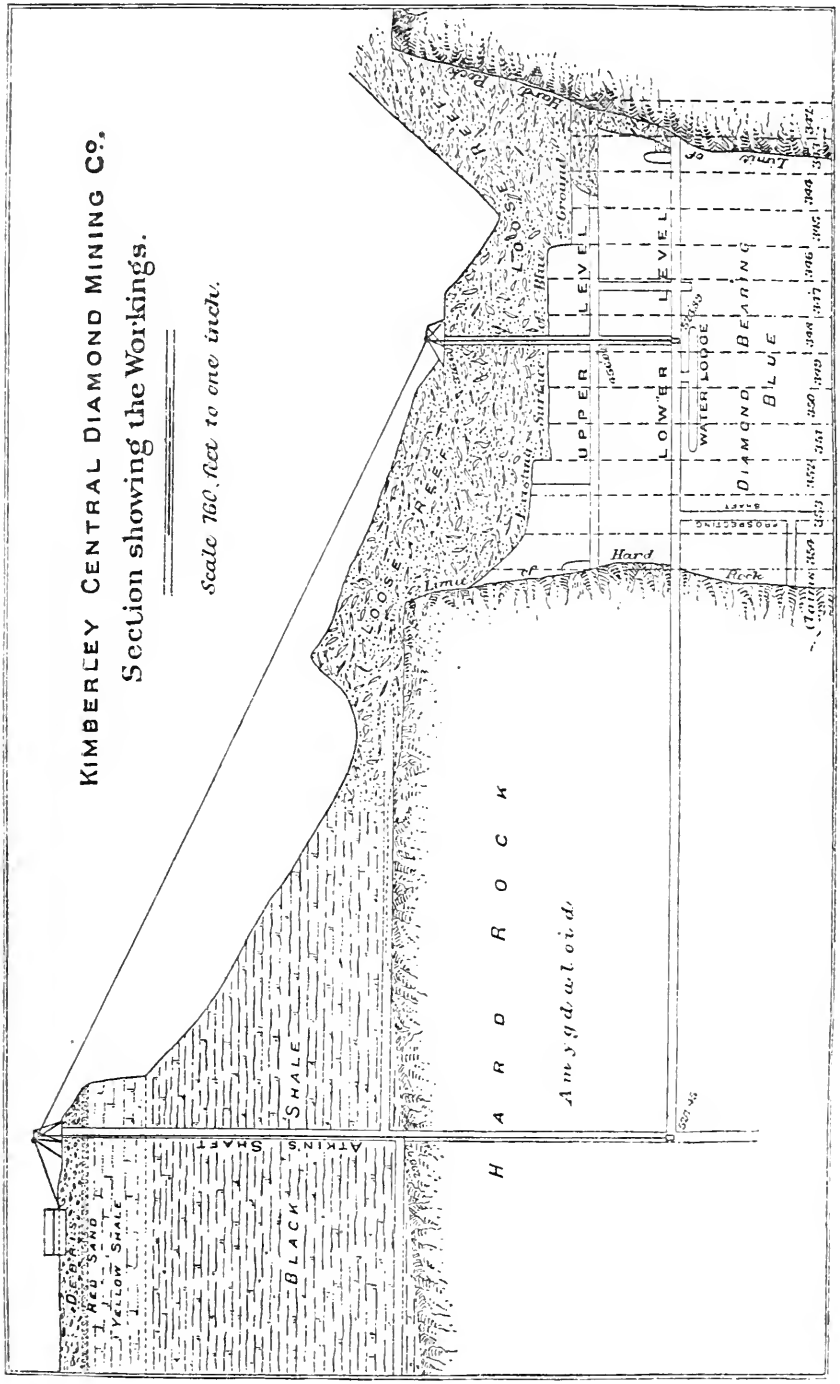
INTERIOR VIEW OF THE KIMBERLEY DIAMOND-MINE.

sold the claims at the ruling prices, which were then, in 1872, fifty to one hundred pounds per claim. Naturally the purchasers found (as they thought) that they had been sold, and they in their turn again planted "the claims on some more of their brother-diggers." A few, however, held their claims on the chance of something turning up, and they had their reward; for, before long, "some one had cut through this hard blue rock and hauled it from the mine into the air. Here it was left for some time exposed to the rays of the sun and the dews and rains of heaven; when one day it was found to have pulverized into a kind of mixed soil, consisting of iron-stones, pieces of hard carbon, garnets, flakes of mica, quartz-crystals, iron pyrites, peridot basalt, and what was not expected, diamonds! Yes, imbedded in this compact mass were numbers of diamonds far exceeding in quantity and quality anything taken from the upper stratum of yellow soil. Diggers had only been scratching the outer skin of the great Kimberley mine." The "yellow ground" is now known to be only the blue ground, which has been changed in color and consistency by exposure to the atmosphere; and the character of the "blue" has not shown any alteration, except that it has become harder and more crystallized, at the depth of six hundred feet, to which the lowest sinkings have been extended. The rock itself is described, generally, as a hydrous magnesian conglomerate, with silica as a base; but it is added that its precise nature is still doubtful, and "a catalogue of all it contains would fill a page." In the shale on the south side of the mine a lump of coal was discovered, and within the mine itself charred-wood fossils have been found. Thin veins of calc-spar are of frequent occurrence. Vaalite, mica, iron pyrites, and hornblende, are disseminated through the 'blue,' besides fragments and masses of shale, sandstone, and bowlders of dolerite."

The working of the mines has been seriously impeded and made vastly more expensive by the treacherous nature of the "reef," or formation of yellowish and blue shale with which its upper part is surrounded. Wherever this rock is exposed it becomes disintegrated, and is then liable to slip down at any time, like a land-slide, upon the miners working beneath it, covering up their claims and making it extremely difficult as well as dangerous to work in them; for the removal of such masses as came down soon grew to be a formidable task. In fact, the mine has not yet fully recovered from the troubles which this reef has imposed upon its workers. These most affected the claim-holders near the margin of the mine. At the same time those near the center were embarrassed by the accumulation of water in their holdings. "It soon became a recognized principle that both reef and water should be treated as common enemies, and accordingly a general rate was levied upon the whole mine to deal with them." To work more effectually with the reef-removal, the Mining Board erected costly hauling machinery on two of the corners of the mine, and sank a large vertical shaft through the reef at the northeast corner some two hundred yards back from the limit of the claim-ground. The shaft, however, was stopped as soon as the hard rock was reached at two hundred and eighty-six feet below the surface. Tramways were laid to take the place of the carts that had been used, and the capacity of all the machinery for removing material was greatly increased. Early in 1878 one quarter of the claims were covered by reef, which was hauled out at an expense of four shillings per load of sixteen cubic feet. In 1879–'80 the board expended £300,000 on the removal of reef, *débris*, and water; in 1881, £200,000; and in 1882, more than £500,000, while claims were still covered, and other slips were impending. Although at the beginning of 1883 three shafts, one of them four hundred and fifty and another six hundred and fifty feet deep, had been sunk to assist the process, the removal of reef did not keep pace with the constantly recurring slips; and the board having spent £650,000 in eighteen months, and laboring under a deficit of £250,000, could not get its bills discounted. Consequently a "Black Friday" came to the mines, and the value of their shares fell by fifty, seventy-five, and ninety per cent; and holders of shares on which calls were liable to be made "would have been only too glad to have paid men to take them over, so as to free themselves from the liability which they were incurring."

The discovery of the hard rock, says Mr. Reunert in his report, practically confined the reef difficulty within manageable limits, as there is little doubt that this rock will stand without disintegrating, even when exposed to a great depth. But the experience of successive reef-slips has considerably increased the estimate of the shale to be removed to render the mine safe for working on the open or quarry principle. It was at first supposed that the reef would stand if cut back to an angle of 60° receding from the mine; then 45° was spoken of as the angle of repose; but it has now been found that an angle of 30° will be needful. The cost of removing this obstruction has been vastly increased by the failure to apply comprehensive and systematic plans in the beginning; but this failure is apologized for by saying that no one knew what the future of the mine would be, or was ready to venture at once upon so large a permanent outlay as would be required.

The area of the Kimberley mine, originally inclosed within the reef, was about eleven acres. Successive slips and removal of reef have widened the area till it is now twenty-five or thirty acres. The inclosing rocks which form the walls of the diamond-bearing "pipe" converge inward from the surface downward, so that the area of claim-ground is constantly reduced as the mine deepens; but in some of the lowest sinkings, which have gone to more than six hundred feet below the surface, the rock has been found to recede from the mine, and thus to permit the regaining of a certain area of rich ground.

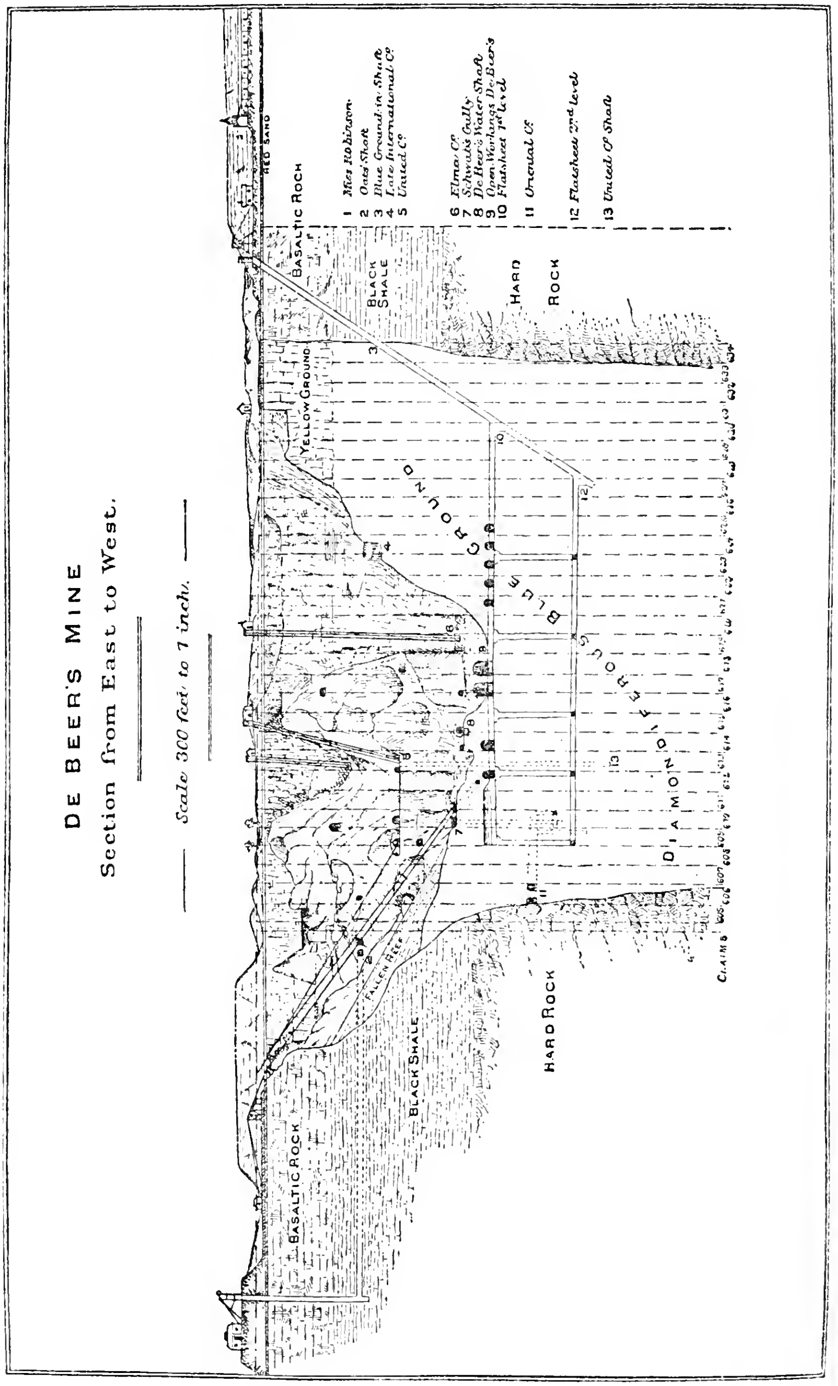

KIMBERLEY CENTRAL DIAMOND MINING Co.
Section showing the Workings.
Scale 160 feet to one inch.
DEBRIS
RED SAND
YELLOW SHALE
BLACK SHALE
ATKINS'S SHAFT
HARD ROCK
Amygdaloid
LOOSE REEF
UPPER LEVEL
LOWER LEVEL
WATER LODGE
DIAMOND BEARING BLUE
Hard Rock
Hard Rock
Limit of
PROSPECTING SHAFT

The difficulties caused by the reef have been at last overcome without having first to remove the accumulation of material by the adoption of a system of shafts and tunnels which is called, after its inventor, "Jones's system." A shaft was sunk through the fallen reef within the mine by letting down a series of caissons till the solid "blue ground" was reached. A hundred feet of loose reef was thus penetrated, after which the shaft could be extended to any desired depth in the "blue," and tunnels driven in all directions, so as to continue the excavation of the mine underground. The scheme had the merit of entailing little initial outlay, while, as soon as the "blue" was reached, the work of opening up the galleries more than paid for itself in the value of the ground removed. Other shafts have been sunk outside of the mine, one being more than five hundred and twenty feet deep, and others going down to the hard rock, and connected by tunnels and cross-tunnels, so built that the cross-tunnels have a wall of hard rock on one side, while the roof and other side are solid "blue." The excavation, says the report, "is then continued by cutting down the 'blue' from the roof overhead; but instead of trucking away the 'blue' as it falls, the rails in the tunnel are taken up and the 'blue' is allowed to pack underfoot, the miners therefore being continually climbing to a higher level, while the height of the tunnel remains uniform, just enough for the miners to be 'in touch' with the roof." In order to preserve safe means of access and egress for the workers in this continually rising chamber, a couple of cross-headings are driven parallel with it, five feet high by four wide, branching out at right angles from either side of the main tunnel, and leaving a solid wall of "blue" ten feet thick between the cross-headings and the main chamber. "A number of inclined passes are then driven at a sharp angle through this wall of blue, connecting the cross-heading with the working-chamber, and where they strike the latter vertical 'pass-pits' are carried up, rising simultaneously with the chamber, and separated from it by a three-inch plank, which prevents the loose pack of blue from filling the passes. At last the overhead excavation has proceeded so far as nearly to strike the fallen reef which at present covers all the open workings in the mine. The crown of the chamber is then broken through at either end, and the loose reef allowed to enter and pack on the top of the excavated blue. A sliding-door in the planks at the bottom of the pass-pits is then opened and the excavated blue drawn off, sliding down the inclined passes into trucks in the cross-headings, which convey it through the main tunnel and shaft to the surface. As the blue is drawn off, the loose reef above it subsides and takes its place till the chamber is entirely emptied of blue and filled with reef. The sliding-doors are then closed, and the excavation of that chamber is complete." This process is repeated, with modifications in the several chambers as they are successively excavated; while in another part of the mine an opposite system of excavation is successfully conducted. A shaft is sunk in the blue to a total depth of five hundred and twelve feet below the red soil, and two sets of workings are opened up—one at this lowest level in course of preparation, while a first level eighty feet higher is now being worked out. At each level two sets of tunnels are used, one above the other, at a vertical distance of fifty feet apart. The upper tunnels give the level at which the excavation of large chambers is begun ; and these are gradually worked downward, the roof being left untouched, while the excavated ground is delivered down vertical passes to the trucks in the lower or main tunnel.

The De Beer's mine is similar in formation to the Kimberley mine, but about one fifth larger in area. The reef incasing it for a depth of one hundred feet is a yellow basalt, after which succeeds a layer of black shale, extending to a total depth of two hundred and ninety feet from the red sand, where the hard igneous rock is struck. Within the mine the diamondiferous soil is "yellow ground" to a depth of one hundred feet from the surface, after which follows an unknown depth of "blue ground." As in the Kimberley mine, the richness of the ground greatly varies in the different sections. Having the advantage of the experience of the Kimberley, this mine has been steered clear of serious difficulties from reef. But some falls of reef which took place in 1883 and 1884, and a fall of nearly half a million loads of top unpayable ground, forced the claim-holders to consider some alternative to continuous working in the open mine ; and it has become apparent that the future excavations must proceed underground. Five out of the seven companies holding the mine have sunk shafts within it for the purpose of reaching the "blue ground." One company has a shaft outside of the reef-margin, with a tunnel leading into the mine at a depth of one hundred and fifty feet from the surface. Another company has sunk a shaft from the outside at an angle of thirty-five degrees from the vertical to a depth of five hundred feet from the surface, from which working-galleries open at depths of five hundred and three hundred and eighty feet. This mine, like the Kimberley, is reduced in size at the cutting in of the hard rock.

The Bultfontein mine is almost circular in shape, with a diameter of about three hundred yards. It does not present equal promise to the operator with the two mines already described, and a considerable proportion of its claims are still unworked, while others have been abandoned on account of the encroachment of a mass of shale upon them. No underground workings having been begun in it, it presents to the casual observer a better idea of the nature of the operations that have been carried on within the last ten years than any of the other three mines, and for that reason it has been chosen to furnish a model of diamond-mining for the Indian and Colonial Exhibition.

The Dutoitspan mine derives its name from the "pan," or small lake, which lies between it and the Bultfontein mine. This pan is filled



De Beer's Mine

Section from East to West.

Scale 300 feet to 1 inch.

by surface drainage after heavy rains, and sometimes covers fifty or sixty acres, when good boating and wild-duck shooting may be had upon it, but in times of drought it is entirely dry. The water of the pan, and of another body, Blankenberg's Vley, is leased by the diggers for mining purposes. Except that it is semicircular instead of being circular or oval, the description of the Dutoitspan is very similar to that of the other mines.

The gems were extracted from the earth, at the beginning, when everything was crude and done in haste, and when water was scarce, by the method of "dry-sorting," which consisted in sifting the excavated ground through hand-sieves, and then passing the finer portions over a sorting-table. By this method as many diamonds were missed as were found, and frequently the yield from the rewashing of the earth over which the process had been performed gave better returns than were gained in the first instance. A modification of the "cradle" was then introduced, but it eventually gave way to the "Rotary Washing-Machine," which is still generally employed. It consists of an annular-shaped pan, from eight to fourteen feet in diameter, which is closed by an outer and an inner rim, of which the inner rim is about four feet in diameter, and is not so high as the outer rim. A vertical shaft rotates in the center of the open space, carrying ten arms radiating around it, each of which has half a dozen vertical knives, or teeth, set within half an inch of scraping the bottom of the pan. The diamondiferous ground, mixed with water, enters through an orifice in the outer rim of the pan, and is stirred up into a ripple by the revolving knives, whereby the lighter stuff comes to the surface and continually floats away through an orifice in the inner rim, while the heavier gravel falls to the bottom of the pan. The mud, or "tailings," which flows to waste over the inner rim, is led by a shoot to a pit, whence it is lifted by a chain and bucket elevator some twenty or thirty feet high. At the top of the elevator the buckets deliver the tailings onto suitable screens, over which the solid mud runs to waste, while the muddy water is led back by an overhead shoot to the machine to assist in forming a puddle of sufficient consistency to float the lighter stones in the pan, and allow only the heaviest ground to accumulate at the bottom. For the better mixing of this puddle, an inclined cylindrical screen is fixed above the level of the pan. The dry ground from the mine is tipped into the upper end of the screen, where it is met by the muddy water from the elevator and a certain amount of clear water. The large stones, of a size unlikely to include diamonds, roll out at the lower end of the cylinder, but the puddle, carrying all the smaller stones with it, passes through the wire netting of the screen and down a shoot into the pan, as above described. At the end of the day's work the machine is stopped, and the contents of the pan, after they have undergone an intermediate cleaning in a cradle, or in a small gravitating machine, called a "pulsator," are emptied upon the sorting-table. The "pulsator" is also often so employed as to dispense with the "panning" process.

At the "river-diggings" (on the Vaal) the diamondiferous deposit is imbedded between bowlders and mixed with fine red sand, and sometimes with lime. The diamonds are separated by sifting the earth through a machine called a "baby"—a kind of swinging sieve, which, the coarser pebbles having been taken out by another sieve impending above it, allows the medium-sized pebbles, supposed to contain diamonds, to roll into a tub, while the finer refuse sand passes through its meshes. The contents of the tub are then gravitated, and the heavier stones are turned upon a "sorting-table," and the diamonds picked out by careful scraping. An experienced digger can tell at a glance, from the appearance of the deposit, what chance there is of "finding well" in it. He knows by sight the heavier stones that occur in diamond-bearing ground, and their presence is a sure sign of diamonds being there too. This is particularly the case with a curiously marked pebble that is streaked with a succession of parallel rings, from which it has received the descriptive name of "banddoom" (bandround). The specific gravity of the "banddoom" is almost identical with that of the diamond, and, where the former is found, experience has taught that the latter may be confidently expected. Beautiful agates are also found in this deposit, as well as quartz-crystals, jaspers, chalcedony, but few garnets, and no iron pyrites or carbon, which occur so plentifully in the Kimberley mines. An assortment of "river-stones" forms a very pretty collection, and it is conceivable enough that, prior to the opening of the diggings, diamonds should have been picked up by the natives and valued as more than ordinarily pretty pebbles. The river-digging is, however, not very profitable in the face of the large returns given by the Kimberley mines, and is now relatively of but little importance.

The whole number of claims in the four mines of Kimberley and Beaconsfield is 3,238, covering about seventy acres of diamondiferous gravel. The whole property is assessed at £5,172,975, or at the rate of £75,000 per acre, and is divided among ninety-eight holders, forty-two of whom are joint-stock companies, and the remaining fifty-six private firms and individuals. The gross capital of the joint-stock companies, which hold 2,211 claims, is returned at £7,970,490; and that of the private holders is estimated at £1,624,900, making the gross capital of the entire mines £9,595,390. The annual expenditure in labor, material, etc., is not less than two million sterling, or ten million dollars. It has been estimated, by the comparison of information from various official sources, that the gross value of diamonds exported from the Cape Colony up to the end of 1885, exclusive of such as were not reported or were illicitly taken away, amounted to £35,000,000. The total yield of diamonds from the Vaal River to date has probably exceeded £2,000,000.

In quality the Vaal River stones are rated highest, in the degree that while in the three years ending with August, 1885, the weight of those sent away from that district was only about $\frac{1}{125}$, that of the entire exports their declared value was as much as $\frac{1}{62}$ of the total value exported. Of the four Kimberley and Beaconsfield mines, Dutoitspan produces the finest stones, ninety per cent being perfect. Bultfontein comes next, with its beautiful white stones, weighing from a quarter of a carat to two carats. De Beer's comes next, and Kimberley last. In absolute value of production, the order is, Dutoitspan, De Beer's, Kimberley, Bultfontein. The largest diamond ever found in Griqualand West was an irregular octahedron from Dutoitspan, slightly spotted, and of yellow color, which weighed 404 carats, or nearly three ounces. The only larger stone than this known to have ever been found was a very imperfect one, discovered near Jagersfontein, which weighed about 500 carats. Another diamond, of 352 carats, has been found at Dutoitspan. The largest stone ever found at Bultfontein weighed a little more than 150 carats. The Bultfontein diamonds, while superior in color to all others except those of Jagersfontein, are of smaller average size than those of the other three mines.

All the diamonds coming from the various South-African mines are said to have a distinct personality, by means of which experts can at once recognize stones from either of the four mines, and tell from which it came, and can again distinguish those of the Kimberley and Beaconsfield mines from those of the river-diggings, and their testimony on this point is accepted by the courts.

All the theories by which the attempt is made to account for these mines recognize them as of volcanic origin. Their form suggests at once the crater of an extinct volcano, or the tube of a geyser. When the attempted explanation goes beyond this, the range of diverging opinions is quite wide. Of these various views, we will refer only to the observation of Sir Henry Roscoe, that the most noteworthy feature of the diamond-bearing rocks of Kimberley is the discovery in the diamond-earth of a volatile crystalline hydrocarbon, soluble in ether, which seems to confirm the hypothesis that the carboniferous shales, which are penetrated by the diamond-bearing pipes, have been the source of the carbon now found in the crystalline state in this gem. The physical structure of the ash, or incombustible portion of the stone, is of a very singular character, and has hitherto not been examined. A careful study of it may possibly throw light on the important question of the mode of formation of the diamond.

MATERIALISM AND MORALITY.

By W. S. LILLY.

"WORDS are grown so false that I am loath to prove reason with them," says Viola in "Twelfth Night." The saying constantly comes to my mind in dealing with the philosophical controversies of the present day. Rigorous definition, careful analysis, precise classification, are no longer in favor. It is an age of loose thinking, and of looser writing; of "idle words, servants to shallow fools." Never, perhaps, was there an age in which the trade of the sophist, whose business it is "to make the worse reason appear the better," was carried on so successfully. Never was there an age in which a writer who feels that he is "a teacher, or nothing," had greater need of well-considered and accurate language. Hence it is that in the papers which I have from time to time contributed to this "Review" I have sought, before entering upon my argument, to state clearly the sense in which I employ my principal terms. Most necessary is it that I should do this in respect of such a word as materialism. There are those who would restrict it to a doctrine which is now discredited for higher minds. What we know of living forces, of the real properties of bodies, has made an end of the old notion of matter reduced merely to solidity and extension. Our better acquaintance with the physiology of the sense-organs has been fatal to the sensism which Professor Clifford contemptuously calls "the crass materialism of the savage." It lingers, indeed, in the lower intellectual regions. Nay, more, it is still widely held there. "Il y a des morts qu'il faut tuer encore." And this is one of them. My present point, however, is that this coarse and vulgar theory is by no means the only form of materialism. Nor is it the form under which materialism is most potently working in the world just now. The more subtile doctrines which have arisen upon the ruins of the old materialistic hypothesis are, in all essentials, identical with it. Positivism, determinism, and much that passes current as agnosticism, are mere varieties of materialism; sublimated expressions of it, perhaps, but true expressions, having in them the root of the matter. Now here I am conscious of a difficulty. Is it fair, one may be asked, to impose the name of materialist upon those who, more or less energetically, repudiate it? I think it is fair, and, more, that it is a duty, if the name truly describes them. Take, for example, the late Mr. Clifford. As we have just seen, he rejects emphatically "the crude materialism of the savage," but only to substitute a materialism which is, indeed, more refined, but which is also, as it seems to me, more irrational. His biographer, Mr. Frederick Pollock, claims that his view is, in truth, "idealistic monism, a very subtile form of idealism," and points out that his conception of the ultimate reality is "mind, not mind as we know it in the complex form of thought and feeling, but those simpler elements of which thought and feeling are built up." Well, of course, materialism affects to be monistic, for it seeks to explain the whole universe in terms of matter. But how is Mr. Clifford's monism idealistic? The element of which "even the simplest feeling is a complex" he calls "mind-stuff." "Matter," he tells us, "is the mental picture of which mind is the thing represented. Reason, intelligence, and volition are properties of a complex, which is made up of elements, themselves not rational, not intelligent, not conscious." Is it possible, Mr. Pollock himself being judge, to call this doctrine idealism? This "mind-stuff," which, we are told, is the thing-in-itself, of which "a moving molecule of organic matter possesses a small piece," and which, "when matter takes the complex form of a living human brain, takes the form of a human consciousness, having intelligence and volition"—how is it possible to account for this "mind-stuff" as anything but matter? Again, consider the teaching of Professor Huxley. With whatever rhetorical ornaments he may gild it, what is its practical outcome but materialism? I am well aware of his opinion that the question "whether there is really anything anthropomorphic, even in man's nature," will ever remain an open one. I do not lose sight of his recognition of "the necessity of cherishing the noblest and most human of man's emotions by worship, for the most part of the silent sort, at the altar of the Unknown and Unknowable." But, on the other hand, I remember his positive declaration that "consciousness is a function of nervous matter, when that nervous matter has attained a certain degree of organization." I remember, too, his confident anticipation that "we shall sooner or later arrive at a mechanical equivalent of consciousness, just as we have arrived at a mechanical equivalent of heat." And I do not forget that singularly powerful passage in his "Lay Sermons"—who that has once read it can forget it?—in which he enforces what he deems "the great truth," that "the progress of science has in all ages meant, and now more than ever means, the extension of the province of what we call matter and causation, and the concomitant gradual banishment, from all regions of human thought, of what we call spirit and spontaniety"; that "as surely as every future grows out of the past and present, so will the physiology of the future gradually extend the realm of matter and law until it is coextensive with knowledge, with feeling, with action." Once more. Let us turn to a teacher more widely influential, perhaps, than even Mr. Huxley. I mean Mr. Herbert Spencer. He, too, recognizes "an unknown and unknowable power without beginning or end in time." He tells us expressly in his "Psychology" that consciousness can not be a mode of movement, and that if we must choose between these two modes of being, as the generative and primitive mode, it would be the first, and not the last, which he would choose. These sayings certainly do not sound like materialism. I think, however, that if we closely examine his writings, we shall find the persistence of force his one formula. With that he will bring for you life out of the non-living; morality out of the unethical; the spiritual out of the physical. The persistence of force! I trust it will not seem to exhibit an unappreciativeness, which I am far from feeling, of the high gifts and unwearied self-devotion of this eminent man, if I say that he has always appeared to me to belong to a class of thinkers aptly described in one of Voltaire's letters: "Des gens que se mettent, sans façon, dans la place de Dieu: qui veulent créer le monde avec la parole." But this autotheism is really materialism in disguise. If all beings, all modes and forms of existence, are but transformations of force, obeying only mechanical laws, the laws of movement—and that is what Mr. Spencer's doctrine amounts to, if there is any meaning in words—what is the universe but a senseless mechanism? Mr. Spencer, indeed, protests against the application to matter of such epithets as "gross" or "brute." He delights to expatiate on its wonderful properties; and in his latest work he speaks of "a universe everywhere alive; alive, if not in a restricted sense, at least in a general sense." Still the fact remains that Mr. Spencer seeks to interpret all things in terms of matter and motion, and holds life to be a mere result of physical forces. There are only two conceivable hypotheses open to us. Either Nature is the outcome of intellect, or intellect is the outcome of Nature. Mr. Spencer's teaching, considered as a whole, is an elaborate argument on behalf of the latter of these hypotheses. And what is this but materialism? I know that Mr. Spencer would call himself a realist. I think that Professor Huxley, in better moments "among the many workings of his mind," would call himself an idealist; and, as we have seen, the friend who has written so well about the late Professor Clifford calls him an idealistic monist. Mr. Pollock, indeed, goes on to observe, "It is hardly worth while to dispute about names, when more serious things remain for discussion." These words seem to me in themselves a revelation, not, indeed, of light, but of darkness; they give us a glimpse of chaos and the void inane. Surely names are the signs of, nay, the substitutes for, ideas; formulas summing up for us, briefly, it may be a train of reasoning, a series of sensations, a multitude of images. Unless we use them as parrots do, which, to be sure, is the habit of many people, they stand to us in the place of things. Hence the immense importance, upon which I have already touched, of exact terminology. If our nomenclature is vague, we shall be continually mistaking one thing for another. "Pantheism or pottheism—what matter, so long as it is true?" Mr. Carlyle asked. But my present inquiry is not if the teaching, whether of the late Mr. Clifford, of Mr. Huxley, of Mr. Herbert Spencer, is true, but what that teaching really is. And my contention is that all these three gifted men, whom I select as types of a host of less famous writers widely influential on English thought, must in strictness be reckoned as materialists. All three do, in effect, express the entire man by matter, his intellectual and moral being as well as his corporal frame. All three do, in effect, restrict our knowledge to the phenomenal universe, of which consciousness and will are, for them, fortuitous or necessary products. Now I am far from asserting that there is anything to prevent us from being spiritualists in psychology, while in cosmology we accept the dynamical explanation, and confess that everywhere in the universe are forces and centers of forces. But this is a very different view from that which regards intellect as a mode of motion, or as a manifestation of physical energy. "The faculties of the mind, feeling, and will," writes Mr. Frederic Harrison, "are directly dependent upon the physical organs. To talk to me of mind, feeling, will, in the absence of physical organs, is to use language which to me, at least, is pure nonsense." Mr. Harrison's creed, it would appear, may be summed up in the simple symbol, "I believe in the brain, the viscera, and the reproductive apparatus." Deity without a stomach is inconceivable to him. This very eloquent and very positive writer has the courage of his opinions. But, as it appears to me, the doctrines of Professor Clifford, of Professor Huxley, of Mr. Herbert Spencer, in their ultimate resolution, are substantially at one with his. Whatever differences divide these illustrious men from one another, they all agree in putting aside, as unverifiable, everything which the senses can not verify; everything beyond the bounds of physical science; everything which can not be brought into a laboratory and dealt with chemically. It will be found in the long run that there are two, and only two, great schools of thought, two schools which, in common with the philosophical writers of Germany, France, and Italy, I shall denominate Spiritualism* and Materialism, until better terms are forthcoming. Spiritualism seeks the explanation of the universe from within, and with Kant holds it as a fundamental truth that the nature of our thinking being imposes our way of conceiving, of valuing, and even of apprehending sensible things. Materialism maintains that in those sensible things must be sought the explanation of our ideas and of our wills. Spiritualism postulates a First Cause possessing absolute freedom, and recognizes true causality in man also, with his endowment of limited and conditioned liberty of the will. Materialism holds that we can know nothing before the proximate and determining causes of phenomena, and demands, in the words of Mr. Huxley, "the banishment from all regions of human thought of what we call spirit and spontaneity." Spiritualism insists upon the unity of consciousness, upon consciousness of personal identity,

* The misuse of the word Spiritualism to denote a certain sect of vulgar charlatans is unfortunate, but "abusus non tollit usum." The Roman Church could hardly be expected to abandon her description of herself as Catholic and Apostolic because these adjectives have been adopted by the followers of Mr. Irving.

upon the *ichheit des Ego*—the selfhood of the Me—as the original and ultimate facts of man's existence. Materialism dissolves the Ego into a collection of sensations, makes of consciousness an accidental and superficial effect of mechanism, and exhibits man as a mere sequence of action and reaction. Spiritualism maintains the absolute nature of ethics; the immutable distinction between moral good and evil. Materialism refers everything to heredity, temperament, environment, convention. Spiritualism affirms the supersensuous, yes, let us venture upon the word, the supernatural, in man, and finds irrefragable evidence of it in

> " . . . this main miracle, that thou art thou,
> With power on thine own act, and on the world."

Materialism makes of the soul, with Professor Tyndall, "a poetical rendering of a phenomenon which refuses the yoke of ordinary mechanical laws," explains will and conscience as merely a little force and heat organized, and, in Coleridge's pungent phrase, "peeps into death to look for life, as monkeys put their hands behind a looking-glass." Such are the two great schools of thought which are disputing the intellect of the world.

Now, I take it, that one of the most striking signs of the times is the extent to which materialism has triumphed throughout Europe. Fifty or sixty years ago it might well have seemed as though Kant had made an end in Germany of the doctrine which, derived by the *philosophes* of the last century from Locke, had been carried to its logical issue by Cabanis and Condillac. In England the school of Reid was, in some sort, doing a similar work. In France the influence of Royer Collard, Maine de Biran, Jouffroy, and Cousin—all, whatever their differences, firmly attached to the main principles of spiritualism—was dominant. In Italy the works of Pasquale Galuppi had diffused some knowledge of the critical philosophy, and Rosmini's "New Essay on the Origin of Ideas" had made its way into many seminaries. Now, all is changed. In Germany a school has arisen based on the empirical doctrines supposed to have been forever discarded, but giving to them a new and more precise form. Of its many able exponents it must suffice here to mention only one, Herr Büchner, whose book on "Matter and Force" has had an immense success in his own country, and has been translated, I believe, into well-nigh all European languages. M. Janet, no mean judge, reckons it as "the tersest, frankest, and clearest system of materialism which has appeared in Europe since the famous 'Système de la Nature.'" It is true that in Germany the influence of these new materialistic doctrines would appear to be on the wane. They are not specially fitted to recommend themselves to the Teutonic mind, with its innate bias to idealism. And they have been vigorously combated by a number of extremely able writers, foremost among whom must be reckoned Lange and Von Hartmann, Ulrici and Lotze. Yet no one can carefully study contemporary German literature without perceiving how potential still is the school which relies wholly upon the positive sciences, and puts aside entirely psychology and metaphysics. Its prevalence in England may be sufficiently indicated by merely mentioning the names of the three accomplished scientists at whose teaching we have already glanced, the late Professor Clifford, Professor Huxley, and Mr. Herbert Spencer, not to speak of Professor Tyndall. But if we would see this way of thinking have free course, if we would fully realize the inglorious liberty of the sons of matter, it is upon France that we must gaze. In that country, at the present moment, the most widely influential school is unquestionably the medico-atheistic : the school which inculcates sensism of the grossest kind, which reeks of the brothel, the latrine, and the torture-trough. "A most superficial and most degraded positivism," M. Beaussire tells us in his recent able work,* "seems to have taken possession of well-nigh all souls." A remnant, indeed, is left in the higher regions of French thought which has not bowed the knee to the Baal of dead mechanism, nor joined itself to the dung-god. In M. Caro and M. Janet, to mention no others, may be found worthy successors of Cousin and Maine de Biran. But unquestionably the two greatest intellectual forces in France at the present time are M. Renan and M. Taine, neither of whom can be claimed by spiritualism. I do not lose sight of the many magnificent passages in which M. Renan pays homage to the supersensuous, the ideal, the divine. Yet there is ever before him the haunting suspicion that, after all, Gavroche may be right—that "jouir et mépriser" may be the last word of the true philosopher. There are those who find the secret of his transitions of thought in the famous *mot* of M. Sardou's comedy, "J'ai assez pratiqué le monde pour savoir qu'on n'a jamais que la conviction de ses intérêts." There are those again who tell us that in his profound and serene intellect every passing phase of contemporary thought is reflected like the clouds in the bosom of the calm ocean. I am not ambitious to decide which explanation is the true one. It is enough for me to point to his own account of himself, which is that he does not know whether or no he is a materialist : "Je ne sais bien si je suis spiritualiste ou matérialiste. Le but du monde, c'est l'idée : mais je ne connais pas un cas où l'idée se soit produite sans matière : je ne connais pas d'esprit pur, ni d'œuvre d'esprit pur." M. Taine has of late years been most prominently before the world as the first living historian of his country, perhaps of any country. But we must not forget that his high place among contemporary thinkers was first won as a philosopher. A closely knit system his is, indeed. But what a system ! A system of mechanism and fatality, dealing with the universe as an immense and

* "Les Principes de la Morale," Paris, 1885. The extremely striking introduction —whence my citation is taken—attracted much notice when it appeared originally in the "Revue des Deux Mondes" of August 1, 1884.

eternal series of visible movements, more or less complex, all reducible to invisible movements, obeying the laws of physics. Reason, intelligence, will, personality are for him mere metaphors. He reduces them all to mechanism and movement. The intellect he regards as a thinking machine, just as the stomach is a digesting machine. He will speak of the soul, if you please; but, like Mr. Tyndall, he warns you that you must take it merely as a poetical expression, a rhetorical figure. With reason did Michelet, after reading his admirably written book on Intelligence, exclaim in dismay, "Il me prend mon moi." France, after all, is still the country in which the movements of the European mind may be most fruitfully studied. If Germany is the mine of ideas, it is France which mints them and makes them current coin. Intellectually considered, Italy and Spain are merely outlying provinces of France, and her influence upon English and Teutonic thinkers, if less magisterial, is hardly less effective.

I consider, then, that if we survey the higher thought of Europe, as a whole, we must find it largely given over to materialism. And if we turn to the more popular literature, in which is the truest expression of society, the same tale is unfolded. What a portent is that large and ever-growing school of "naturalistic" fiction of which M. Zola is the honored and prosperous chief, and which is so eagerly read, and so largely imitated, throughout the civilized world! "Toute métaphysique m'épouvante" that master tells us. His works, he claims, are conceived in the true "scientific" spirit. Matter is for him the only reality, and in its honor he raises pæans "like the shrieks of a hyena at discovering that the universe is all actually carrion." But it is not merely in the literature of the erotic passion, and of the genetic impulse, that the mark of the beast is plainly visible. How many a grave writer of our day has acquired a reputation for originality simply upon the strength of a fantastic physical terminology! Instead of intellect, he speaks of nervous centers; instead of life, of the play of cellular activities; instead of mental energy, of cerebral erethism. And his readers, piquing themselves on their distrust of everything outside the sphere of what they call facts, will "wonder with a foolish face of praise." In truth, every branch of intellectual activity bears witness to the advance of materialism in the popular mind; to the dying out of the old spiritual and ideal types. Thus, in politics, we see the domination of the brute force of numbers, of majorities told by head, becoming almost everywhere an accomplished fact. The instincts and passions of the masses, who are little more than matter in motion, are accepted as the supreme law, in the place of justice and virtue, of reason and religion. Art, too, has bowed her sacred head to the materialistic yoke. It has been well remarked that in the pictures of the old masters you have not merely a natural scene, but the soul of the painter who looked upon it. That attribute of soul is precisely what has been steadily dying out from modern art, as the physical sciences have more and more imposed their sway upon our ways of thinking and our habits of life. The true function of the artist, as of the metaphysician, is to seek the reason and essence of things. But while to the philosopher this reason and essence are revealed in a principle, in a general conception, to the artist they are revealed in a concrete form, as individual beauty. Both are seekers after truth; but the beautiful is the splendor of the true, and the sense of beauty is the light of the intellect. Materialism quenches that light. All that the artist now usually aims at is to copy exactly, to reproduce phenomena. And here, indeed, he attains some measure of success, especially if the phenomena be of the lupanarian order. Well has Mr. Ruskin pronounced the art of our own time to be "a poor toy, petty or vile." Perhaps its portraits are its most valuable achievement. But their value is rather historical than artistic; they tell their own tale about the men and women of the age. What that tale is, a distinguished French painter not long ago pointed out. They are the abstract and brief chronicle, he observed, in which is written the spiritual history of our century. During the first half of it, the neck is thrown back, the head is upturned toward heaven, as if in quest of some ideal vision. As we draw toward our own days the neck contracts, the head sinks nearer the shoulders, as though by the instinctive movement of a bull gathering himself up for the combat. It is because the battle of life has become more intense, because the mind is concentrated upon the material interests of the world. The habit of thought—curious verification of a law of Darwin's—has transformed the physical habit. A most delicate and sensitive intellect—to whom British philistinism, with its "certitude de mauvais goût," has largely paid the homage of its contumely and scorn—notes the same fact in his own way. The substitution of the laws of dead matter for the laws of the moral nature, the subjection of the soul to things, "écraser l'homme spirituel, dépersonalizer l'homme" is, as Amiel discerned, the dominant tendency of the times. It appears to me that if you survey the civilized world you find everywhere the same tokens. Everywhere I note the practical triumph of that earth-to-earth philosophy which will see nothing beyond experience, which shuts off the approach of science to all that can not be weighed and measured. Everywhere literature and art are losing themselves in the most vulgar sensuousness. Look throughout Europe, and what, in every country, are the great majority of the educated classes, who give the tone to the rest? Skeptics in religion, doubters in ethics, given over to industrialism, and to the exact sciences which minister to it, respecting nothing but accomplished fact and palpable force, with nerves more sensitive than their hearts, seeking to season the platitude of existence by a more or less voluptuous æstheticism, a more or less prurient hedonism. Such are the men of this new age. The intellectual atmosphere is charged with materialism; and breathe that atmosphere we must, whether we will or no.

Now the question which I would invite my readers to ponder is, What, in such an age, is the prospect before us as regards those ethical conceptions upon which society has as yet existed? Can they live in this blighted air? And, without them, what will become of the moral life of mankind? Do not let us mistake the fact. We are living in a crisis of the world's history, a great crisis, for it is a moral crisis. Fifty years ago Jouffroy wrote his celebrated article, "Comment finissent les dogmes." He had in view religious dogmas only, and especially the distinctive tenets of Christianity. He might now, were he alive, discuss the question in a much wider sense. Philosophy, as well as religion, has its traditional bases. Certain it is, as mere matter of history, apart from all controversy, that the ethical ideas which have hitherto ruled the conduct of mankind, have rested upon certain metaphysical *credenda*. As certain is it that the postulates of the old philosophy—a First Cause, by which the universe was brought into existence, and that for a good end, the personality of man, his limited and conditioned liberty and moral responsibility, the immateriality and immortality of the Ego, the absolute nature of ethics—certain it is that these things are now very commonly put aside as antiquated delusions. Kant is no less discredited than St. Paul in the eyes of the prophets of materialism. The practical reason fares as badly as the Christian revelation at the hands of the sages of positivism. Nay, every newspaper hack of Continental Liberalism is ready with his gibe at M. de l'Absolu and Mdlle. l'Âme. In the novel, in the play, in the babble of the drawing-room or the dinner-table, the most august and venerable of ethical doctrines are called in question and denied. Even the supreme authority of conscience is impugned. To its "Thou must" the answer is prompt: "On what compulsion must I? tell me that!" Its "dogmatism" is contemptuosly rejected, for physical science—the only science—is supposed to have given an explanation of it, fatal alike to its authoritativeness and to its coerciveness. No longer may we account of it with St. Paul, as the divine law written in the heart; no longer with Kant, as the law laid by a man's higher self upon himself. Has not Mr. Herbert Spencer resolved its obligation into a long-sighted selfishness? its sanction into a brain-track? Certain it is that every civilization which the world has as yet known, has been reared upon an ethical, not a physical foundation. A common belief in dogmas of morality—I use the word dogmas advisedly—has hitherto been the very condition of social cohesion. To speak of Europe only, its public order has ever been based upon the conviction, deep down in the hearts of all, at the very root of their moral and spiritual being, that man was encompassed by duties—duties which, however grudgingly performed or brutally violated, in countless instances, were everywhere undoubtingly recognized as the divinely imposed laws of life;

no more to be chosen by men or women, Savonarola reminds the fugitive Romola, than birthplace, or father, or mother could be chosen, though men might choose to forsake them. So long as a moral code exists, and is generally acknowledged and revered, the fact of individual deflections from it, whether they be more or less numerous, is of comparatively small importance. It is the invalidation of the moral code, the prevalence of ethical agnosticism, the skepticism as to all first principles, which I account so portentous a sign of our own times. It seems to me to be the token of a decadent and moribund civilization.

Let us look at the matter as practical men. Assuredly what we may expect from materialism is not construction but destruction in all the most important departments of human life. Consider only two. The bond of civil society is obedience to law, fenced round with penalties ; but legislation rests upon the doctrine of human responsibility. "Will," Kant tells us, "is a kind of causality belonging to living beings in so far as they are rational ; and freedom is such a property of causality as enables them to be efficient agents, independently of outside causes determining them ; while, on the other hand, necessity is that property of all irrational beings, which consists in their being determined to activity by the influence of outside causes." This conception of human freedom underlies the notion of crime. Yes ; the sense of crime is bound up with the belief in man's power of choice, and in his obligation to choose rightly. Where there is no faculty to judge of acts, as right or wrong, and to elect between them, as in a young child or a lunatic, there is no criminal responsibility, for there are no persons. Personality manifests itself under the condition of free-will, influenced but not coerced by motives, a will which has the power of choice between two alternative courses. Without that power assuredly there is no moral acountability. *Ought* is a meaningless word without *Can*. Now, every school and variety of materialism does, in effect, deny free-will, be the denial more or less direct, more or less veiled.* Either we are presented with the *a posteriori* argument, so elaborately worked out by Buckle, which aims at establishing, by the aid of statistics, that what we call morality is subject to fixed laws, like the course of the stars or the return of the seasons ; that what we call virtue and vice are the results of physical causes, as regular as those which rule the germination of plants or the procreation of animals. Or the *a priori* road is followed, and we are told that though we can determine our actions according to our wishes, we can not determine our wishes. The will—what we call will—is exhibited to us as always governed by the strongest motives, the force of which is not due to us, for we suffer them, we do

* Thus, Mr. Clifford, in words, admits man's free agency ; but, in fact, he reduces it to the mere shadow of a great name. It is with him nothing but the consciousness of being attracted, not propelled.

not originate them. Do we reply: "True, indeed; but though we do not create motives we have in our own hands the culture of the will; we are the architects of our own characters, because character is formed by acts, is, in fact, a chain of acts, and it rests with us to forge the first link of that chain"? The rejoinder is: "You beg the question. That first act was determined by motives; it was produced by the influence of the strongest of the external causes. Your so-called free-will is an illusion; it is really the sum of the many influences, of various kinds, which have been brought to bear upon a man, not merely individually, but during the countless generations of his existence in his ancestors. These have given to his soul—what we poetically call soul—its characteristic ply. 'Such as we are made of such we be.' What we call virtue and vice are, in M. Taine's striking phrase, 'merely products, like sugar and vitriol.' They are mainly the outcome of heredity. Francis of Assisi was necessarily a saint. Eccelino was necessarily a monster. Alexander Borgia could not by any means have become a Savonarola, nor Savonarola an Alexander Borgia. 'A poor devil can't command courage any more than he can make himself six feet high,' says Colonel Newcome, in extenuation of the cowardice of his nephew Barnes. No; nor can he command purity, or veracity, or pitifulness. 'To doubt the necessary nature of an action when a motive is presented to a given character,' writes the German philosopher, 'is just as absurd as to doubt that the three angles of a triangle are equal to two right angles.'" The conclusion to which materialism in all its schools is inevitably led, is that will is not what Kant has defined it, but only a word to hide our ignorance of causation, a modality of instinctive acts, accompanied by a certain degree of sensation. But with what is called metaphysical liberty, with freedom of volition, merit and demerit disappear too. Human causality, human spontaneity, human responsibility, all die before the "uncreating word" of materialism. Its doctrine of absolute irresponsibility makes an end of ethics; its criminal legislation can be nothing but *leges sine moribus vanæ.* For the sting of punishment is not the actual fact—"stone walls do not a prison make"—but the moral disapprobation of which the fact is evidence. But how visit with moral disapprobation those who were incapable of doing anything but what they did? Poor victims of temperament, of heredity, of environment, they are to be pitied, not blamed; while, indeed, we seclude them for the protection of our persons and pockets; for we are the numerical majority, we can appeal to the *ultima ratio* of force, if to nothing higher. It is no fancy picture which I am now drawing. Fifty years ago Balzac wrote: "Crime has been made poetical; tears are driveled over assassins." True as his words were then, they are even truer now. The idea of law as the embodied conscience of a nation of persons, the belief in justice, in the old sense, as something quite transcending mere expediency—*fiat justitia pereat mundus*—the conception of the civil magistrate as a minister of the retribution ordained by that justice as "the other half of crime," these things have well-nigh died out from the popular mind, as in place of the old spiritual principles of ethics, materialism refers us to natural history.

If law, with penal sanctions, be the bond of civil society, the family is certainly its foundation. But the family depends upon marriage. Now marriage, as it exists in Europe, is mainly the creation of spiritualism embodied in Christianity. Wordsworth gave utterance to no mere poetical fancy, but to the exact truth, when he wrote of "pure religion breathing household laws." What will become of marriage, and of that virtue of chastity of which it is the guardian, if we are to be governed by purely physical canons? In a recent work I have pointed out what, as a matter of fact, was the effect upon matrimony of the materialism dominant in France during the second half of the last century.* I may here note how the legislators of the first French Republic dealt with it. The National Convention reduced it to a civil contract terminable, under circumstances, by the decree of a secular tribunal. As a fitting pendant to this enactment, the law of the 12th of Brumaire, year II of the Republic, placed natural children upon a footing of almost complete equality with children born in wedlock. Cambacérès, who acted as the *rapporteur* of the measure, would, indeed, have put them upon a completely equal footing. "The existing differences," he urged, "are the result of pride and superstition; they are ignominious and contrary to justice." The materialists who now sit in the seat of those sages are bent upon continuing and completing their work. The recent law on divorce is but a beginning, quite insufficient to satisfy the aspirations of the bolder spirits who pant for the entire abolition of marriage upon the ground that it is "the tomb of love, and the chief cause of stupidity (*abêtissement*) and ugliness (*enlaidissement*), in the human race." I suppose it must be conceded that stupidity and ugliness are the rule, rather than the exception, in the human race. But I have never been able to follow the reasoning which professes to find the source of these evils in matrimony, and their remedy in sexual promiscuity. Certain it is, however, that every school of materialism tends to the substitution of ephemeral connections, of what Mr. John Morley calls, after Rousseau, "marriage according to the truth of nature" †—it is usually known as concubinage—for permanent and indissoluble wedlock, a "servitude" for which no sanction is found in physical science. "The moral and legal rule of marriage will be changed," M. Renan lately prophesied to the well-pleased students gathered around him at the *Grand-Véfour*; "the old Roman and Christian law will one day seem too exclusive, too narrow." And evidently M. Renan thinks that day of redemption drawing nigh.

* "Chapters in European History," vol. ii, pp. 153–159, second edition.

† See his account of Rousseau's mock marriage in vol. i, chap. iv, of his work on that philosopher.

Certain it is that every school of materialism, by banishing the spiritual element from love, reduces it to a mere physical function, and makes of chastity a monkish superstition. "La morale," a keen witted Frenchman observed to me the other day, "est considérée par la Révolution comme une cléricale." And the abounding obscenity of literature and art in France is viewed with satisfaction by her present rulers, as the most effective weapon wherewith to combat this dreaded foe of the Third Republic. We in England have not as yet got so far as advanced thinkers across the Channel. But unquestionably we are on the road. The establishment of the divorce court has been a heavy blow at the old spiritual conceptions of wedlock hitherto unquestioningly received among us. And who can estimate the demoralizing effect of the flood of filth vomited throughout the country from that "common sewer of the realm"? The warnings of the saintly Keble "against profane dealing with holy matrimomy" have received only too ample justification. On every side we may discern the tokens how the old reverence for woman, and for that virtue of chastity which is the very citadel of her moral being, is being sapped among us, as materialism advances. The "Christian idea of purity," the Dean of St. Paul's some time ago told the University of Oxford, "has still a hold upon our society, imperfectly enough." Can we ask a more anxious question than whether this hold will continue? No one can help seeing, I think, many ugly symptoms. The language of revolt is hardly muttered. The ideas of purity, which we have inherited and thought sacred, are boldly made the note and reproach of the Christians. "Ugly symptoms," indeed, abound on every side. How largely has our popular literature lost itself in a so-called "realism," devoid of that ethical sentiment, without which, Goethe has well observed, "the actual is the vulgar, the low, the gross"! The art of the novelist in particular, how very generally is it degraded to the delineation of what the author of "Sapho"—no mean authority on such a subject—calls "ces amours de chair"; "those merely animal loves," wherein, he tells us, "there is no esteem, no respect, for the object of the passion, and brutality ever wells up, whether in anger or in caresses." Consider how the art of painting has been debased into a vehicle of mere sensuousness, a provocative of pruriency, a "procuress to the lords of hell." It is a true saying of Pope that a man shows not only his taste, but his virtue, by the pictures which hang upon walls. What a tale as to the virtue of this age do its pictorial exhibitions unfold! Or, again, think—but briefly—of the apotheosis of prostitution which is one distinctive note of our epoch. And here let me guard myself against misconception. I know well that the poor in virtue, as the poor in worldly wealth, we shall have always with us. I know that, in our present highly complex and artificial civilization, the rude proceedings, whereby the men of simpler ages sought to enforce chastity, would be out of date. I think it probable that in any age they did more harm than good. True, emphatically, in the existing condition of society, is St. Augustine's warning "Aufer meretrices de rebus humanis, turbaveris omnia libidinibus." And, this being so, I believe the true function of the state is to control and regulate what it must regard as a necessary evil, and to minimize, as far as may be, the resultant mischiefs, moral and physical. These miserable women are the guardians of our domestic purity. The "macte virtute esto" of Cato was prompted by a true knowledge of human nature. But, at all events, the infamy of the courtesan's trade has hitherto been generally recognized. It has been reserved for the materialism of the nineteenth century to make of this unclean creature an object of admiration, of envy, nay, of respect; the heroine of drama, the type of comedy, the theme of romance, the arbitress of fashion, the model curiously and attentively studied by great ladies with daughters to marry, by *débutantes* with husbands to find. ' Hoc fonte derivata clades." One need not go very much into general society to know how widely spread the corruption is. The language of the *lupanar* is heard from virginal lips. Things which it is a shame even to speak of, are calmly discussed by beauty just out of the nursery. A taint of lubricity hangs over "society." It is as though body and soul were steeped in materialism. "Si un homme épouse une jeune femme, élevée à la moderne, il risque fort d'épouser une petite courtisane," debauched in mind, if physically intact. It is an observation of Bernard de Vaudricourt in "La Morte," and is true of other countries than France. If any one wishes to see what the woman of the future, brought up without religious or metaphysical dogmas, in the school of physical facts, accepted as the only facts, is fated to become, let him survey "Sabine Tallevaut," as she is depicted for us in the pages of that admirably written book. Nowhere has M. Feuillet displayed more signally the sagacity and acuteness of his observation of social phenomena, or his singular psychological skill. I know not whether to admire more his refinement or his audacity, his mastery of the emotions or his descriptive power. Certain it is that the morality of the world, in the long run, is determined by women. Certain it is that the philosopher was well warranted when he wrote, " ce qu'on appelle l'homme moral, est formé sur les genoux de sa mère." Certain it is that for woman the idea of duty is, as a matter of fact, inseparably bound up with the spiritual conceptions derived by her from religion. And as certain is it that, if she once lose those conceptions, nothing but lack of personal attractions, or absence of opportunity, saves her from utter ethical degradation. Let us never forget that the difference between man and woman is not merely of physical conformation. It is psychical. "Woman is not undeveloped man, but diverse." She is governed far more by instinct, by impulse, by affections, than by logic, by purpose, by principles. For her, materialism means more utter ruin than for man, for it extinguishes the ideal which is her one light of life. As it destroys the sense of duty in man, so is it fatal to pure love in woman. Bring up woman in the positivist school, and you make of her a monster: the very type of ruthless cynicism, of all-engrossing selfishness, of unbridled passion.

There are eminent persons, I am well aware, to whom these conclusions will be extremely distasteful. Writers, whose names alone suffice to establish a claim upon our respectful attention, discourse to us of "independent morality." Professor Huxley, as I remember, somewhere protests with characteristic vehemence, "I will not for a moment admit that morality is not strong enough to hold its own." After all, however, the vital question is not what this accomplished physicist will admit, but what, from the nature of the case, is likely to happen. No doubt Professor Huxley, emancipated from belief in angel or spirit, still guides himself by the same ethical rules as before. I do not myself know anything of the early history of this illustrious man; but I suppose that, like the rest of us, he was brought up upon the Catechism. At all events I am quite sure that he is the product of many generations of Christian progenitors. What M. Renan happily calls the moral sap of the old belief—"la sève morale de la vieille croyance"—still courses through his spiritual being. His materialism takes credit for virtues springing from quite another source: "Miraturque novas frondes et non sua poma." He knows, far better than I do, the influence of heredity and of environment upon character. He is well aware how deeply rooted in the past are those ethical principles whereby human life is still largely governed, even among materialists. The question is, Can you uproot those principles and expect them to flourish upon a quite different soil? Morality in Professor Huxley, I can well believe, is strong enough to hold its own. But will it be strong enough in Professor Huxley's great-grandchildren? "It takes several generations for Christian morality to get into the blood," the missionaries in Samoa told Baron von Hübner. It will doubtless take several generations for Christian morality to get out of the blood. And then? Kant, a teacher whom Professor Huxley very highly esteems, held the existence of God and a future life to be necessary postulates of morality. Certainly, as a matter of fact, they are postulates upon which morality has hitherto rested. They have supplied the strongest incentives to duty, and to that self-sacrifice which the performance of duty usually involves. What is to take the place, in the generations to come, of those old spiritual dogmas? I do not know of any materialists who so much as profess to care for duty for its own sake. They are all agreed that personal interest or selfishness, of course enlightened selfishness, is for the future to be the foundation of ethics. It is from sympathy, they tell us, that the highest virtues must now spring. "Sympathy," they confidently maintain, "will impel us to seek the agreeable consciousness that results from the healthy exercise of the energies of our nature, and to promote it in others by the exercise of virtue and benevolence." "A deep and intelligent sympathy with the race" is to supply the place of the old sanctions. I pity the race. There is no conceivable motive why we should trouble ourselves about the welfare of others if they are mere automatic organisms. The "agreeable consciousness that results from the healthy exercise of the energies of our nature" is grotesquely inadequate to support the old rule of right action, "Fais ce que dois, advienne que pourra." Physical science is utterly unable to supply any reason why we should "prefer a noble life before a long." If ever M. Renan, who is of the house and lineage of Balaam, the son of Beor, said a true word, it is this, "L'intérêt personnel n'inspire que la lâcheté." It is an insult to my understanding to tell me that selfishness, however sublimated, will yield the same fruits as self-sacrifice; that from natural history, from physiology, from chemistry, you can derive the elements of moral force. Justice, duty, love, are the idlest of words, if no echo come back to them from beyond the grave. "Virtue will never cease to be admirable so long as man is man," a Teutonic materialist urges. I entirely agree. But if you empty the human mammal of the ideas of God, right, responsibility, immortality, he ceases to be man. "'A had him from me Christian, and, look, if the fat villain have not transformed him ape!" And then assuredly virtue will cease to be admirable to him. Not indeed that I am now pleading for Christianity. Still less am I pleading for any special form of it. There is little in Christian morality that is exclusively Christian; and I am not prepared to assert that many of the most precious of the ethical elements of our civilization might not survive a general decay of specifically Christian dogmas. My present contention is more general. It is this: that morality can have root only in the spiritual nature of man. If from that happy soil, watered by the river of life and refreshed by the dews of heaven, you transplant it to the rocks and sands of materialism, wither and die it must. "Independent morality." Yes. I quite allow that, in a sense, morality is independent. It is independent of all systems, religious and metaphysical; of all facts, psychological or historical. It is, as Kant has so well shown—that is to me the great achievement of his philosophy—it is a formal law, transcending all persons and all conditions, and sovereign over all: a law of ideal relation, universally obligatory upon all wills. It is as absolute as are the laws of mathematics, and concerning it even God is not free; for it has its source in his nature, and "he can not deny himself." In this sense it is independent; but it is not independent of personality. How can we predicate ethicalness or unethicalness of a thing? I maintain, then, that whether morality be regarded subjectively or objectively, materialism is fatal to it. Only a person is capable of a moral act; and materialism destroys personality. No action can be obligatory, in the strict sense, unless it is binding upon us without regard to its consequences and without reference to any personal end.

But, according to the universal teaching of all schools of materialism, the true criterion of the value of an action is its pleasurable tendency. Show that it is not conducive to human gratification, and it ceases to be virtuous. Let materialism efface from the world the old spiritual dogmas on which ethics have hitherto rested, and the somber picture of the great poet of the last century will assuredly be realized :

> "Religion, blushing, veils her sacred fires
> And, unawares, Morality expires:
> Nor public flame, nor private, dares to shine,
> Nor human spark is left, nor glimpse divine."

It may be said that consequences are the scarecrows of fools ; that things are what they are, and that it is our wisdom to see them as they are ; that their consequences will be what they will be, and can in no way alter the facts of which they are the outcome. This is true enough, but it is not the whole truth. Consequences assuredly do deserve our attention. "Exitus acta probat" is a faithful saying, and with it accords that utterance of a diviner wisdom, "By their fruits ye shall know them." A *reductio ad absurdum* is a good logical process. Why? Because man consists in reason. And so the fact, if fact it be, as I believe, that the doctrines of materialism issue in unreason, in that "universal darkness" of which Pope prophesied, raises a strong presumption against them. If they are true, the last word of philosophy is spoken in the verse of Baudelaire, "Resigne-toi, mon âme, dors ton sommeil de brute." But to tell me that this is the conclusion of the whole matter, is in flat contradiction to my deepest and most assured certitudes. Certain to me is the reasonableness of the universe. It is cosmos, not chaos. Be its final cause immeasurably distant from our knowledge, yet every part of the process through which it moves is found, when examined, to be intelligible. "Nothing is that errs from law." There are mysteries, indeed, and locked doors, everywhere. As Hegel saw, every convex is concave, and every concave convex. But this is not contradiction nor unreason. Certain also to me is the supremacy of duty. Whatever is doubtful, of this I am ineffably sure, that right I must do, whatever the result ; that on the side of right I must be, whether it triumph or not. And as certain to me is the sacredness of love. I do not speak of those *amours de chair* at which we have glanced with the French novelist, but of that passion for the ideal, which is the light of life :

> "Luce intellettual, piena d' amore,
> Amor di vero ben pien di letizia,
> Letizia che trascende ogni dolore."

But that which in my heart is love, in my conscience justice, in my intellect reason, is one and the same thing ; it is the primary truth of which my whole moral being is full ; and any doctrine which contradicts it is condemned already, even if it were, apparently, as well established, as materialism is, manifestly, ill established. For, in truth, all schools of materialists are confronted with the initial difficulties of the unity of consciousness, of the individuality and permanency of the Ego. These facts, however complex and obscure—and I fully recognize their complexity and obscurity—are the stumbling-block of every school of materialists, just as they are the adamantine foundation of all spiritual philosophy. And the writer who tries to explain them away, who asks me to believe, upon his *ipse dixit*, that consciousness is a mere fortuitous result of mechanism, that thought is a mere cerebral secretion, that the Ego is a mere sensation, is a dogmatist who makes far greater demands upon my faith than any Catholic theologian or Jewish rabbi. I know not any article of any creed, which so largely taxes my credulity, as does the proposition that there can be consciousness without personality, memory without identity, duty without liberty.

No sort of compromise, no kind of *modus vivendi*, appears to me to be possible between these two schools of Spiritualism and Materialism. I admit, indeed, that we may learn much from many teachers whose theories I judge most false. Let us gladly accept their facts. Let us also narrowly scrutinize their arguments. The writers whom I have in view, however admirable in other respects, are assuredly great corrupters of words. Too often they exhibit the smallest power of distinguishing between a nude hypothesis and a proved conclusion. They omit necessary links in their reasoning, as when, for example, they pass at a bound over the unbridged gulf between automatic consciousness and deliberate volition. They tell us, perhaps not quite accurately,* that the brain is the origin of thought, and then they proceed to argue as though they had demonstrated that it is the cause of thought, and that intellect is a mere cerebral phenomenon. They talk glibly of causation, as if they knew all about it, overlooking their entire inability to analyze the causal nexus. And what shall we say of the way in which they habitually employ the term law? It really means in physics no more than "an observed uniformity of sequence or coexistence." But they give it a sort of personification, and speak of it as a cause. They confound it with necessity, forgetting that there is all the difference in the world between invariable regularity and necessary regularity. I confess—I trust I may be pardoned for so far yielding to a professional instinct—that I often put down the pompous pages of some of the most famous of them and say to myself: "If only I could have you under cross-examination for half an hour! How easy it would be to turn you inside out to show what a mass of arbitrary assumption, of confused ratiocination, of audacious sophism, all this brilliant rhetoric is!"

But let us remember that philosophy is the science of principles,

* I should prefer saying that the brain is the organ, not of thought, but of the *phantasmata* which furnish thought with materials: it is the organ of imagination in the highest sense.

and so ought to be encyclical, encyclopedic. It must no more neglect the positive sciences than the moral. "A wider metaphysic would not harm our physic" is an abundantly true warning. Equally true is it that a wider physic would not harm our metaphysic. It fills me with amazement to see the arguments still resorted to by men, learned in a fashion, and full of good-will, but quite unacquainted with the true bearings of the problems which agitate the modern mind, nay, totally devoid of the intellectual training necessary in order so much as to appreciate them. Their blindness to the signs of the times is well-nigh miraculous. They do not seem to possess even the sensitive membrane which Darwin tells us is the beginning of the eye. Who, that is at all competent to judge, can deny that the progress of the sciences during the present century has largely revolutionized the world of thought, or doubt that many old questions assume quite a new aspect in the light now shed upon them? To take one instance only, spiritualism is by no means bound up with the old dualistic conceptions which posit matter and mind as two incomprehensibly related substances, eternally alien from each other, and irreconcilably hostile. For myself, every day that I live I become more confirmed in the belief, which I expressed some years ago in this "Review," that "the old wall of partition between spirit and matter is cracking in all directions," that "we shall come to recognize a thinking substance, of which thought is the foundation, not the resultant." * Even now—in words which I gladly borrow from Mr. Romanes—may we not regard "any sequence of natural causation as the merely phenomenal aspect of the ontological reality, the outward manifestation of an inward meaning"? The reality is spiritual, the phenomenon merely the shadow and the symbol. Materialism, like all errors, is but the distortion of a truth. It is a false expression of that tendency to unity which is so marked a characteristic of the modern mind, and which is not false. A century ago Lessing pronounced ἓν καὶ πᾶν to be the last word of philosophy. Whatever exception may be taken to the formula, assuredly, it adumbrates a great verity. And as assuredly none can be further removed from the apprehension of that verity than those who, like Diderot, discern in the universe nothing but "one and the same phenomenon indefinitely diversified." Enveloped as we are, according to the profound doctrine of the old Vedic sages, in the veil of Mâya, what grosser illusion can there be than to mistake the fleeting shows apprehensible by our senses for the Self-Existent? "Of him, and through him, and to him are all things." Most near and most hidden all phenomena consist by him, all phenomena point to him, his indwelling leads us to his transcendence. "Wer darf ihn nennen?"—Who dare name him?—the poet asks.†

* See "Ancient Religion and Modern Thought," pp. 340–345, third edition.

† Compare St. Augustine: "Quid dicit aliquis, cum de Te dicit? Et væ tacentibus de Te; quoniam loquaces muti sunt."

And the question may well seem reverent when we think how men talk of the Absolute and Eternal as if he were altogether such a one as themselves, as if he were the man in the next room. Let us celebrate that higher ignorance, that *docta ignorantia,* as the mystics speak, which is the last word alike of physics, of philosophy, of religion: "Deveni in altitudinem maris et silui."—*Fortnightly Review.*

SCIENCE AND MORALS: A REPLY.

By Professor T. H. HUXLEY.

IN spite of long and, perhaps, not unjustifiable hesitation, I begin to think that there must be something in telepathy. For evidence, which I may not disregard, is furnished by the last number of the "Fortnightly Review," that, among the hitherto undiscovered endowments of the human species, there may be a power even more wonderful than the mystic faculty by which the esoterically Buddhistic sage "upon the farthest mountain in Cathay" reads the inmost thoughts of a dweller within the homely circuit of the London postal district. Great, indeed, is the insight of such a seer; but how much greater is his who combines the feat of reading, not merely the thoughts of which the thinker is aware, but those of which he knows nothing; who sees him unconsciously drawing the conclusions which he repudiates, and supporting the doctrines which he detests! To reflect upon the confusion which the working of such a power as this may introduce into one's ideas of personality and responsibility is perilous—madness lies that way. But truth is truth, and I am almost fain to believe in this magical visibility of the non-existent when the only alternative is the supposition that the writer of the article on "Materialism and Morality" in the current number of the "Fortnightly Review," in spite of his manifest ability and honesty, has pledged himself, so far as I am concerned, to what, if I may trust my own knowledge of my own thoughts, must be called a multitude of errors of the first magnitude.

I so much admire Mr. Lilly's outspokenness, I am so completely satisfied of the uprightness of his intentions, that it is repugnant to me to quarrel with anything he may say; and I sympathize so warmly with his manly scorn of the vileness of much that passes under the name of literature in these times, that I would willingly be silent under his by no means unkindly exposition of his theory of my own tenets, if I thought that such personal abnegation would serve the interest of the cause we both have at heart. But I can not think so. My creed may be an ill-favored thing, but it is mine own, as Touchstone says of his lady-love, and I have so high an opinion of the solid virtues of the object of my affections that I can not calmly see her personated by a wench who is much uglier and has no virtue worth speaking of. I hope I should be ready to stand by a falling cause if I had ever adopted it; but suffering for a falling cause, which one has done one's best to bring to the ground, is a kind of martyrdom for which I have no taste. In my opinion, the philosophical theory which Mr. Lilly attributes to me—but which I have over and over again disclaimed—is untenable and destined to extinction; and I not unreasonably demur to being counted among its defenders.

After the manner of a mediæval disputant, Mr. Lilly posts up three theses, which, as he conceives, embody the chief heresies propagated by the late Professor Clifford, Mr. Herbert Spencer, and myself. He says that we agree "(1) in putting aside, as unverifiable, everything which the senses can not verify; (2) everything beyond the bounds of physical science; (3) everything which can not be brought into a laboratory and dealt with chemically" (page 477, preceding article).

My lamented young friend Clifford, sweetest of natures though keenest of disputants, is out of reach of our little controversies; but his works speak for him, and those who run may read a refutation of Mr. Lilly's assertions in them. Mr. Herbert Spencer hitherto has shown no lack either of ability or of inclination to speak for himself; and it would be a superfluity, not to say an impertinence, on my part to take up the cudgels for him. But for myself, if my knowledge of my own consciousness may be assumed to be adequate (and I make not the least pretension to acquaintance with what goes on in my "Unbewusstsein"), I may be permitted to observe that the first proposition appears to me to be not true; that the second is in the same case; and that, if there be gradations in untrueness, the third is so monstrously untrue that it hovers on the verge of absurdity, even if it does not actually flounder in that logical limbo. Thus to all three theses I reply in appropriate fashion, *Nego*—I say No; and I proceed to state the grounds of that negation, which the proprieties do not permit me to make quite so emphatic as I could desire.

Let me begin with the first assertion, that I "put aside, as unverifiable, everything which the senses can not verify." Can such a statement as this be seriously made in respect of any human being? But I am not appointed apologist for mankind in general, and, confining my observations to myself, I beg leave to point out that, at this present moment, I entertain an unshakable conviction that Mr. Lilly is the victim of a patent and enormous misunderstanding, and that I have not the slightest intention of putting that conviction aside because I can not "verify" it either by touch, or taste, or smell, or hearing, or sight, which (in the absence of any trace of telepathic faculty) make up the totality of my senses.

Again, I may venture to admire the clear and vigorous English in which Mr. Lilly embodies his views; but the source of that admiration does not lie in anything which my five senses enable me to discover in the pages of his article, and of which an orang-outang might be just as acutely sensible. No, it lies in an appreciation of literary form and logical structure by æsthetic and intellectual faculties which are not senses, and which are not unfrequently sadly wanting where the senses are in full vigor. My poor relation may beat me in the matter of sensation; but I am quite confident that, when style and syllogisms are to be dealt with, he is nowhere.

If there is anything in the world which I do firmly believe in it is the universal validity of the law of causation; but that universality can not be proved by any amount of experience, let alone that which comes to us through the senses. And, when an effort of volition changes the current of my thoughts, or when an idea calls up another associated idea, I have not the slightest doubt that the process to which the first of the phenomena in each case is due, stands in the relation of cause to the second. Yet the attempt to verify this belief by sensation would be sheer lunacy. Now, I am quite sure that Mr. Lilly does not doubt my sanity, and the only alternative seems to be the admission that his first proposition is erroneous.

The second thesis charges me with putting aside "as unverifiable" "everything beyond the bounds of physical science." Again, I say No. Nobody, I imagine, will credit me with a desire to limit the empire of physical science; but I really feel bound to confess that a great many very familiar and, at the same time, extremely important phenomena lie quite beyond its legitimate limits. I can not conceive, for example, how the phenomena of consciousness as such, and apart from the physical process by which they are called into existence, are to be brought within the bounds of physical science. Take the simplest possible example, the feeling of redness. Physical science tells us that it commonly arises as a consequence of molecular changes propagated from the eye to a certain part of the substance of the brain, when vibrations of the luminiferous ether of a certain character fall upon the retina. Let us suppose the process of physical analysis pushed so far that one could view the last link of this chain of molecules, watch their movements as if they were billiard-balls, weigh them, measure them, and know all that is physically knowable about them. Well, even in that case we should be just as far from being able to include the resulting phenomenon of consciousness, the feeling of redness, within the bounds of physical science, as we are at present. It would remain as unlike the phenomena we know under the names of matter and motion as it is now. If there is any plain truth upon which I have made it my business to insist over and over again it is this; and, whether it is a truth or not, my insistence upon it leaves not a shadow of justification for Mr. Lilly's assertion.

But I ask in this case, also, how is it conceivable that any man in possession of all his natural faculties should hold such an opinion? I do not suppose that I am exceptionally endowed because I have all my life enjoyed a keen perception of the beauty offered us by nature and by art. Now, physical science may, and probably will, some day enable our posterity to set forth the exact physical concomitants and conditions of the strange rapture of beauty. But, if ever that day arrives, the rapture will remain, just as it is now, outside and beyond the physical world; and, even in the mental world, something superadded to mere sensation. I do not wish to crow unduly over my humble cousin the orang, but in the æsthetic province, as in that of the intellect, I am afraid he is nowhere. I doubt not he would detect a fruit amid a wilderness of leaves where I could see nothing; but I am tolerably confident that he has never been awe-struck, as I have been, by the dim religious gloom, as of a temple devoted to the earth-gods, of the tropical forest which he inhabits. Yet I doubt not that our poor long-armed and short-legged friend, as he sits meditatively munching his durian fruit, has something behind that sad Socratic face of his which is utterly "beyond the bounds of physical science." Physical science may know all about his clutching the fruit and munching it and digesting it, and how the physical titillation of his palate is transmitted to some microscopic cells of the gray matter of his brain; but the feelings of sweetness and of satisfaction which for a moment hang out their signal-lights in his melancholy eyes are as utterly outside the bounds of physics as is the "fine frenzy" of a human rhapsodist.

Does Mr. Lilly really believe that, putting me aside, there is any man with the feeling of music in him who disbelieves in the reality of the delight which he derives from it, because that delight lies outside the bounds of physical science, not less than outside the region of the mere sense of hearing? But, it may be, that he includes music, painting, and sculpture under the head of physical science, and in that case I can only regret I am unable to follow him in his ennoblement of my favorite pursuits.

The third thesis runs that I put aside as "unverifiable" "everything which can not be brought into a laboratory and dealt with chemically"; and once more, I say No. This wondrous allegation is no novelty; it has not unfrequently reached me from that region where gentle (or ungentle) dullness so often holds unchecked sway—the pulpit. But I marvel to find that a writer of Mr. Lilly's intelligence and good faith is willing to father such a wastrel. If I am to deal with the thing seriously, I find myself met by one of the two horns of a dilemma. Either some meaning, as unknown to usage as to the dictionaries, attaches to "laboratory" and "chemical," or the proposition is (what am I to say in my sore need for a gentle and yet appropriate word?)—well—unhistorical.

Does Mr. Lilly suppose that I put aside as "unverifiable" all the truths of mathematics, of philology, of history? And, if I do not, will he have the great goodness to say how the binomial theorem is to be dealt with "chemically," even in the best appointed "laboratory"; or where the balances and crucibles are kept by which the various theories of the nature of the Basque language may be tested; or what reagents will extract the truth from any given history of Rome, and leave the errors behind as a residual calx?

I really can not answer these questions, and unless Mr. Lilly can, I think he would do well hereafter to think more than twice before attributing such preposterous notions to his fellow-men, who, after all, as a learned counsel said, are vertebrated animals.

The whole thing perplexes me much; and I am sure there must be an explanation which will leave Mr. Lilly's reputation for common sense and fair dealing untouched. Can it be—I put this forward quite tentatively—that Mr. Lilly is the victim of a confusion, common enough among thoughtless people, and into which he has fallen unawares? Obviously, it is one thing to say that the logical methods of physical science are of universal applicability, and quite another to affirm that all subjects of thought lie within the province of physical science. I have often declared my conviction that there is only one method by which intellectual truth can be reached, whether the subject-matter of investigation belongs to the world of physics or to the world of consciousness; and one of the arguments in favor of the use of physical science as an instrument of education which I have oftenest used is that, in my opinion, it exercises young minds in the appreciation of inductive evidence better than any other study. But while I repeat my conviction that the physical sciences probably furnish the best and most easily appreciable illustrations of the one and indivisible mode of ascertaining truth by the use of reason, I beg leave to add that I have never thought of suggesting that other branches of knowledge may not afford the same discipline; and assuredly I have never given the slightest ground for the attribution to me of the ridiculous contention that there is nothing true outside the bounds of physical science. Doubtless people who wanted to say something damaging, without too nice a regard to its truth or falsehood, have often enough misrepresented my plain meaning. But Mr. Lilly is not one of these folks, at whom one looks and passes by, and I can but sorrowfully wonder at finding him in such company.

So much for the three theses which Mr. Lilly has nailed on to a page of this "Review." I think I have shown that the first is inaccurate, that the second is inaccurate, and that the third is inaccurate; and that these three inaccurates constitute one prodigious, though I doubt not unintentional, misrepresentation. If Mr. Lilly and I were dialectic gladiators, fighting in the arena of the "Fortnightly," under the eye of an editorial lanista, for the delectation of the public, my best tactics would now be to leave the field of battle. For the question whether I do, or do not, hold certain opinions is a matter of fact, with regard to which my evidence is likely to be regarded as conclusive—at least until such time as the telepathy of the unconscious is more generally recognized.

However, some other assertions are made by Mr. Lilly, which more or less involve matters of opinion whereof the rights and wrongs are less easily settled, but in respect of which he seems to me to err quite as seriously as about the topics we have been hitherto discussing. And the importance of these subjects leads me to venture upon saying something about them, even though I am thereby compelled to leave the safe ground of personal knowledge.

Before launching the three torpedoes which have so sadly exploded on board his own ship, Mr. Lilly says that with whatever "rhetorical ornaments I may gild my teaching," it is "materialism." Let me observe, in passing, that rhetorical ornament is not in my way, and that gilding refined gold would, to my mind, be less objectionable than varnishing the fair face of truth with that pestilent cosmetic, rhetoric. If I believed that I had any claim to the title of "materialist," as that term is understood in the language of philosophy and not in that of abuse, I should not attempt to hide it by any sort of gilding. I have not found reason to care much for hard names in the course of the last thirty years, and I am too old to develop a new sensitiveness. But, to repeat what I have more than once taken pains to say in the most unadorned of plain language, I repudiate, as philosophical error, the doctrine of materialism as I understand it, just as I repudiate the doctrine of spiritualism as Mr. Lilly presents it, and my reason for thus doing is, in both cases, the same; namely, that, whatever their differences, materialists and spiritualists agree in making very positive assertions about matters of which I am certain I know nothing, and about which I believe they are, in truth, just as ignorant. And further, that, even when their assertions are confined to topics which lie within the range of my faculties, they often appear to me to be in the wrong. And there is yet another reason for objecting to be identified with either of these sects; and that is that each is extremely fond of attributing to the other, by way of reproach, conclusions which are the property of neither, though they infallibly flow from the logical development of the first principles of both. Surely a prudent man is not to be reproached because he keeps clear of the squabbles of these philosophical Bianchi and Neri, by refusing to have anything to do with either?

I understand the main tenet of materialism to be that there is nothing in the universe but matter and force, and that all the phenomena of Nature are explicable by deduction from the properties assignable to these two primitive factors. That great champion of materialism whom Mr. Lilly appears to consider to be an authority in physical science, Dr. Büchner, embodies this article of faith on his title-page. *Kraft und Stoff*—force and matter—are paraded as the Alpha and Omega of existence. This I apprehend is the fundamental article of the faith materialistic; and whosoever does not hold it is condemned by the more zealous of the persuasion (as I have some reason to know) to the Inferno appointed for fools or hypocrites. But all this I heartily disbelieve; and, at the risk of being charged with wearisome repetition of an old story I will briefly give my reasons for persisting in my infidelity. In the first place, as I have already hinted, it seems to me pretty plain that there is a third thing in the universe, to wit, consciousness, which, in the hardness of my heart or head, I can not see to be matter or force, or any conceivable modification of either, however intimately the manifestations of the phenomena of consciousness may be connected with the phenomena known as matter and force. In the second place, the arguments used by Descartes and Berkeley to show that our certain knowledge does not extend beyond our states of consciousness, appear to me to be as irrefragable now as they did when I first became acquainted with them some half-century ago. All the materialistic writers I know of who have tried to bite that file have simply broken their teeth. But, if this is true, our one certainty is the existence of the mental world, and that of *Kraft und Stoff* falls into the rank of, at best, a highly probable hypothesis.

Thirdly, when I was a mere boy, with a perverse tendency to think when I ought to have been playing, my mind was greatly exercised by this formidable problem, What would become of things if they lost their qualities? As the qualities had no objective existence and the thing without qualities was nothing, the solid world seemed whittled away—to my great horror. As I grew older, and learned to use the terms matter and force, the boyish problem was revived, *mutato nomine.* On the one hand, the notion of matter without force seemed to resolve the world into a set of geometrical ghosts, too dead even to jabber. On the other hand, Boscovich's hypothesis, by which matter was resolved into centers of force, was very attractive. But when one tried to think it out, what in the world became of force considered as an objective entity? Force, even the most materialistic of philosophers will agree with the most idealistic, is nothing but a name for the cause of motion. And if, with Boscovich, I resolved things into centers of force, then matter vanished altogether and left immaterial entities in its place. One might as well frankly accept idealism and have done with it.

I must make a confession, even if it be humiliating. I have never been able to form the slightest conception of those "forces" which the materialists talk about, as if they had samples of them many years in bottle. They tell me that matter consists of atoms, which are separated by mere space devoid of contents; and that, through this void, radiate the attractive and repulsive forces whereby the atoms affect one another. If anybody can clearly conceive the nature of these things which not only exist in nothingness, but pull and push there with great vigor, I envy him for the possession of an intellect of larger grasp, not only than mine, but than that of Leibnitz or of Newton.* To me the "chimæra, bombinans in vacuo quia comedit secundas intentiones" of the schoolmen, is a familiar and domestic creature compared with such "forces." Besides, by the hypothesis, the forces are not matter; and thus all that is of any particular consequence in the world turns out to be not matter on the materialist's own showing. Let it not be supposed that I am casting a doubt upon the propriety of the employment of the terms "atom" and "force," as they stand among the working hypotheses of physical science. As formulæ which can be applied, with perfect precision and great convenience, in the interpretation of Nature, their value is incalculable; but, as real entities, having an objective existence, an indivisible particle which nevertheless occupies space, is surely inconceivable; and with respect to the operation of that atom, where it is not, by the aid of a "force" resident in nothingness, I am as little able to imagine it as I fancy any one else is.

Unless and until anybody will resolve all these doubts and difficulties for me, I think I have a right to hold aloof from materialism. As to spiritualism, it lands me in even greater difficulties when I want to get change for its notes-of-hand in the solid coin of reality. For the assumed substantial entity, spirit, which is supposed to underlie the phenomena of consciousness, as matter underlies those of physical nature, leaves not even a geometrical ghost when these phenomena are abstracted. And, even if we suppose the existence of such an entity apart from qualities—that is to say a bare existence—for mind, how does anybody know that it differs from that other entity, apart from qualities, which is the supposed substratum of matter? Spiritualism is, after all, little better than materialism turned upside down. And if I try to think of the "spirit" which a man, by this hypothesis, carries about under his hat, as something devoid of relation to space, and as something indivisible even in thought, while it is, at the same time, supposed to be in that place and to be possessed of half a dozen different faculties, I confess I get quite lost.

As I have said elsewhere, if I were forced to choose between materialism and idealism, I should elect for the latter; and I certainly would have nothing to do with the effete mythology of spiritualism. But I am not aware that I am under any compulsion to choose either the one or the other. I have always entertained a strong suspicion that the sage who maintained that man is the measure of the universe was sadly in the wrong, and age and experience have not weakened that conviction. In following these lines of speculation I am re-

* See the famous "Collection of Papers," published by Clarke in 1717. Leibnitz says, "'Tis also a supernatural thing that bodies should *attract* one another at a distance without any intermediate means." And Clarke, on behalf of Newton, caps this as follows: "That one body should attract another without any intermediate *means* is, indeed, not a *miracle*, but a contradiction; for, 'tis supposing something to act where it is not."

minded of the quarter-deck walks of my youth. In taking that form of exercise, you may perambulate through all points of the compass with perfect safety, so long as you keep within certain limits: forget those limits, in your ardor, and mere smothering and spluttering, if not worse, await you. I stick by the deck, and throw a life-buoy now and then to the struggling folk who have gone overboard; and all I get for my humanity is the abuse of all whenever they leave off abusing one another.

Tolerably early in life I discovered that one of the unpardonable sins, in the eyes of most people, is for a man to presume to go about unlabeled. The world regards such a person as the police do an unmuzzled dog, not under proper control. I could find no label that would suit me, so, in my desire to range myself and be respectable, I invented one; and, as the chief thing I was sure of was that I did not know a great many things that the —ists and the —ites about me professed to be familiar with, I called myself an agnostic. Surely no denomination could be more modest or more appropriate; and I can not imagine why I should be every now and then haled out of my refuge and declared sometimes to be a materialist, sometimes an atheist, sometimes a positivist; and sometimes, alas and alack, a cowardly or reactionary obscurantist!

I trust that I have, at last, made my case clear, and that, henceforth, I shall be allowed to rest in peace—at least, after a further explanation or two, which Mr. Lilly proves to me may be necessary. It has been seen that my excellent critic has original ideas respecting the meaning of the words "laboratory" and "chemical"; and, as it appears to me, his definition of "materialist" is quite as much peculiar to himself. For, unless I misunderstand him, and I have taken pains not to do so, he puts me down as a materialist (over and above the grounds which I have shown to have no foundation); firstly, because I have said that consciousness is a function of the brain; and, secondly, because I hold by determinism. With respect to the first point, I am not aware that there is any one who doubts that, in the proper physiological sense of the word function, consciousness, in certain forms at any rate, is a cerebral function. In physiology we call function that effect, or series of effects, which results from the activity of an organ. Thus, it is the function of muscle to give rise to motion; and the muscle gives rise to motion when the nerve which supplies it is stimulated. If one of the nerve-bundles in a man's arm is laid bare and a stimulus is applied to certain of the nervous filaments, the result will be production of motion in that arm. If others are stimulated, the result will be the production of the state of consciousness called pain. Now, if I trace these last nerve-filaments, I find them to be ultimately connected with part of the substance of the brain, just as the others turn out to be connected with muscular substance. If the production of motion, in the one case, is properly said to be the function of the muscular substance, why is the production of a state of consciousness, in the other case, not to be called a function of the cerebral substance? Once upon a time, it is true, it was supposed that a certain "animal spirit" resided in muscle and was the real active agent. But we have done with that wholly superfluous fiction so far as the muscular organs are concerned. Why are we to retain a corresponding fiction for the nervous organs?

If it is replied that no physiologist, however spiritual his leanings, dreams of supposing that simple sensations require a "spirit" for their production, then I must point out that we are all agreed that consciousness is a function of matter, and that particular tenet must be given up as a mark of materialism. Any further argument will turn upon the question, not whether consciousness is a function of the brain, but whether all forms of consciousness are so. Again, I hold it would be quite correct to say that material changes are the causes of psychical phenomena (and, as a consequence, that the organs in which these changes take place have the production of such phenomena for their function), even if the spiritualistic hypothesis had any foundation. For nobody hesitates to say that an event A is the cause of an event Z, even if there are as many intermediate terms, known and unknown, in the chain of causation as there are letters between A and Z. The man who pulls the trigger of a loaded pistol placed close to another's head certainly is the cause of that other's death, though, in strictness, he "causes" nothing but the movement of the finger upon the trigger. And, in like manner, the molecular change which is brought about in a certain portion of the cerebral substance by the stimulation of a remote part of the body would be properly said to be the cause and the consequent feeling, whatever unknown terms were interposed between the physical agent and the actual psychical product. Therefore, unless materialism has the monopoly of the right use of language, I see nothing materialistic in the phraseology which I have employed.

The only remaining justification which Mr. Lilly offers for dubbing me a materialist, *malgré moi*, arises out of a passage which he quotes, in which I say that the progress of science means the extension of the province of what we call matter and force, and the concomitant gradual banishment from all regions of human thought of what we call spirit and spontaneity. I hold that opinion now, if anything, more firmly than I did when I gave utterance to it a score of years ago, for it has been justified by subsequent events. But what that opinion has to do with materialism I fail to discover. In my judgment it is consistent with the most thoroughgoing idealism, and the grounds of that judgment are really very plain and simple.

The growth of science, not merely of physical science, but of all science, means the demonstration of order and natural causation among phenomena which had not previously been brought under those conceptions. Nobody who is acquainted with the progress of scientific thinking in every department of human knowledge, in the course of the last two centuries, will be disposed to deny that immense provinces have been added to the realm of science; or to doubt, that the next two centuries will be witnesses of a vastly greater annexation. More particularly in the region of the physiology of the nervous system, is it justifiable to conclude from the progress that has been made in analyzing the relations between material and psychical phenomena, that vast further advances will be made; and that, sooner or later, all the so-called spontaneous operations of the mind will have, not only their relations to one another, but their relations to physical phenomena, connected in natural series of causes and effects, strictly defined. In other words, while, at present, we know only the nearer moiety of the chain of causes and effects, by which the phenomena we call material give rise to those which we call mental; hereafter, we shall get to the further end of the series.

In my innocence, I have been in the habit of supposing that this is merely a statement of facts, and that the good Bishop Berkeley, if he were alive, would find such facts fit into his system without the least difficulty. That Mr. Lilly should play into the hands of his foes, by declaring that unmistakable facts make for them, is an exemplification of ways that are dark, quite unintelligible to me. Surely Mr. Lilly does not hold that the disbelief in spontaneity—which term, if it has any meaning at all, means uncaused action—is a mark of the beast materialism? If so, he must be prepared to tackle many of the Cartesians (if not Descartes himself), Spinoza and Leibnitz among the philosophers, Augustine, Thomas Aquinas, Calvin and his followers, among theologians, as materialists—and that surely is a sufficient *reductio ad absurdum* of such a classification.

The truth is, that in his zeal to paint "materialism," in large letters, on everything he dislikes, Mr. Lilly forgets a very important fact, which, however, must be patent to every one who has paid attention to the history of human thought; and that fact is, that every one of the speculative difficulties which beset Kant's three problems, the existence of a Deity, the freedom of the will, and immortality, existed ages before anything that can be called physical science, and would continue to exist if modern physical science were swept away. All that physical science has done has been to make, as it were, visible and tangible some difficulties that formerly were more hard of apprehension. Moreover these difficulties exist just as much on the hypothesis of idealism as on that of materialism.

The student of Nature who starts from the axiom of the universality of the law of causation can not refuse to admit an eternal existence; if he admits the conservation of energy, he can not deny the possibility of an eternal energy; if he admits the existence of immaterial phenomena in the form of consciousness, he must admit the possibility, at any rate, of an eternal series of such phenomena; and, if his studies have not been barren of the best fruit of the investigation of Nature, he will have enough sense to see that when Spinoza says "Per Deum intelligo ens absolute infinitum, hoc est substantiam constantem infinitis attributis," the God so conceived is one that only a very great fool would deny, even in his heart. Physical science is as little atheistic as it is materialistic.

So with respect to immortality. As physical science states this problem, it seems to stand thus: Is there any means of knowing whether the series of states of consciousness, which has been causally associated for threescore years and ten with the arrangement and movements of innumerable millions of successively different material molecules, can be continued, in like association, with some substance which has not the properties of "matter and force"? As Kant said, on a like occasion, if anybody can answer that question, he is just the man I want to see. If he says that consciousness can not exist except in relation of cause and effect with certain organic molecules, I must ask how he knows that; and if he says it can, I must put the same question. And I am afraid that, like jesting Pilate, I shall not think it worth while (having but little time before me) to wait for an answer.

Lastly, with respect to the old riddle of the freedom of the will. In the only sense in which the word freedom is intelligible to me—that is to say, the absence of any restraint upon doing what one likes within certain limits—physical science certainly gives no more ground for doubting it than the common sense of mankind does. And if physical science, in strengthening our belief in the universality of causation and abolishing chance as an absurdity, leads to the conclusions of determinism, it does no more than follow the track of consistent and logical thinkers in philosophy and in theology before it existed or was thought of. Whoever accepts the universality of the law of causation as a dogma of philosophy, denies the existence of uncaused phenomena. And the essence of that which is improperly called the free-will doctrine is that occasionally, at any rate, human volition is self-caused, that is to say, not caused at all; for to cause one's self one must have anteceded one's self—which is, to say the least of it, difficult to imagine.

Whoever accepts the existence of an omniscient Deity as a dogma of theology, affirms that the order of things is fixed from eternity to eternity; for the foreknowledge of an occurrence means that the occurrence will certainly happen; and the certainty of an event happening is what is meant by its being fixed or fated.*

* I may cite in support of this obvious conclusion of sound reasoning, two authorities who will certainly not be regarded lightly by Mr. Lilly. These are Augustine and Thomas Aquinas. The former declares that "Fate" is only an ill-chosen name for Providence.

"Prorsus divina providentia regna constituuntur humana. Quæ si propterea quisquam fato tribuit, quia ipsam Dei voluntatem vel potestatem fati nomine appellat, *sententiam teneat, linguam corrigat.*"—Augustinus *De Civitate Dei*, V, c. i.

The other great doctor of the Catholic Church, "Divus Thomas," as Suarez calls him, whose marvelous grasp and subtilty of intellect seem to me to be almost without a paral-

Whoever asserts the existence of an omnipotent Deity, and that he made and sustains all things, and is the *causa causarum*, can not, without a contradiction in terms, assert that there is any cause independent of him; and it is a mere subterfuge to assert that the cause of all things can "permit" one of these things to be an independent cause.

Whoever asserts the combination of omniscience and omnipotence as attributes of the Deity, does implicitly assert predestination. For he who knowingly makes a thing and places it in circumstances the operation of which on that thing he is perfectly acquainted with, does predestine that thing to whatever fate may befall it.

Thus, to come, at last, to the really important part of all this discussion, if the belief in a God is essential to morality, physical science offers no obstacle thereto; if the belief in immortality is essential to morality, physical science has no more to say against the probability of that doctrine than the most ordinary experience has, and it effectually closes the mouths of those who pretend to refute it by objections deduced from merely physical data. Finally, if the belief in the uncausedness of volition is essential to morality, the student of physical science has no more to say against that absurdity than the logical philosopher or theologian. Physical science, I repeat, did not invent determinism, and the deterministic doctrine would stand on just as firm a foundation as it does if there were no physical science. Let any one who doubts this read Jonathan Edwards, whose demonstrations are derived wholly from philosophy and theology.

Thus, when Mr. Lilly, like another Solomon Eagle, goes about proclaiming "Woe to this wicked city!" and denouncing physical science as the evil genius of modern days—mother of materialism, and fatalism, and all sorts of other condemnable isms—I venture to beg him to lay the blame on the right shoulders; or, at least, to put in the dock, along with Science, those sinful sisters of hers, Philosophy and Theology, who, being so much older, should have known better than the poor Cinderella of the schools and universities over which they have so long dominated. No doubt modern society is diseased enough; but then it does not differ from older civilizations in that respect.

lel, puts the whole case into a nutshell, when he says that the ground for doing a thing in the mind of the doer is as it were the pre-existence of the thing done:

"Ratio autem alicujus fiendi in mente actoris existens est quædam præ-existentia rei fiendæ in eo" (*Summa*, Qu. xxiii, Art. i).

If this is not enough, I may further ask what "Materialist" has ever given a better statement of the case for determinism, on theistic grounds, than is to be found in the following passage of the *Summa*, Qu. xiv, Art. xiii:

"Omnia quæ sunt in tempore, sunt Deo ab æterno præsentia, non solum ea ex ratione quâ habet rationes rerum apud se presentes, ut quædam dicunt, sed quia ejus intuitus fertur ab æterno supra omnia, prout sunt in sua præsentialitate. *Unde manifestum est quod contingentia infallibiliter a Deo cognoscuntur*, in quantum subduntur divino conspectui secundum suam præsentialitatem; et tamen sunt futura contingentia, suis causis proximis comparata."

Societies of men are fermenting masses, and as beer has what the Germans call "Oberhefe" and "Unterhefe," so every society that has existed has had its scum at the top and its dregs at the bottom; and I doubt if any of the "ages of faith" had less scum or less dregs, or even showed a proportionally greater quantity of sound wholesome stuff in the vat. I think it would puzzle Mr. Lilly or any one else to adduce convincing evidence that, at any period of the world's history, there was a more wide-spread sense of social duty, or a greater sense of justice, or of the obligation of mutual help, than in this England of ours. Ah! but, says Mr. Lilly, these are all products of our Christian inheritance; when Christian dogmas vanish, virtue will disappear too, and the ancestral ape and tiger will have full play. But there are a good many people who think it obvious that Christianity also inherited a good deal from paganism and from Judaism, and that if the Stoics and the Jews revoked their bequest the moral property of Christianity would realize very little. And, if morality has survived the stripping off of several sets of clothes which have been found to fit badly, why should it not be able to get on very well in the light and handy garments which Science is ready to provide?

But this by-the-way. If the diseases of society consist in the weakness of its faith in the existence of the God of the theologians, in a future state, and in uncaused volitions, the indication, as the doctors say, is to suppress theology and philosophy, whose bickerings about things of which they know nothing have been the prime cause and continual sustenance of that evil skepticism which is the Nemesis of meddling with the unknowable.

Cinderella is modestly conscious of her ignorance of these high matters. She lights the fire, sweeps the house, and provides the dinner, and is rewarded by being told that she is a base creature devoted to low and material interests; but in her garret she has fairy visions out of the ken of the pair of shrews who are quarreling down-stairs. She sees the order which pervades the seeming disorder of the world; the great drama of evolution with its full share of pity and terror, but also with abundant goodness and beauty, unrolls itself before her eyes; and she learns in her heart of hearts the lesson, that the foundation of morality is to have done, once and for all, with lying; to give up pretending to believe that for which there is no evidence, and repeating unintelligible propositions about things beyond the possibilities of knowledge.

She knows that the safety of morality lies neither in the adoption of this or that philosophical speculation, or this or that theological creed, but in a real and living belief in that fixed order of Nature which sends social disorganization upon the track of immorality as surely as it sends physical disease after physical trespasses; and of that firm and lively faith it is her high mission to be the priestess.—*Fortnightly Review.*

SOME POINTS ON THE LAND QUESTION.

By OLIVER B. BUNCE.

IN a recent number of a religious periodical there occurred the following sentence: "There can be no question as to the abstract proposition that land is not a proper subject for private ownership; that labor alone creates wealth, and labor does not create land."

It is obvious from the appearance of a statement like this in a publication of high standing that many worthy people are half ready to accept Mr. Henry George's theory of a common ownership in land. They are not ready, perhaps, to sanction his scheme of ruthless confiscation, but they are saying to themselves that at bottom his theory is right, and they are wondering whether land can not ultimately be restored to the community, to which, it is said, it rightfully belongs. My purpose, therefore, in reply to the proposition so confidently affirmed by the writer I have quoted, is to make good the following points:

1. That land, no less than other things, is a proper subject for private ownership.

2. That labor alone does not create wealth.

3. That labor creates the conditions that make land wealth just as much as it creates the conditions that make other things wealth.

And, in continuance of the subject, I hope to show—

4. That the greater part of the land is now practically held by the community, for it enjoys in common all that the land produces.

5. That the confiscation of the rental value of land by means of taxation would in the main be a confiscation of the proceeds of labor.

6. That unearned increment in land, of which so much is said, is not more hurtful to the community than other forms of unearned increment.

7. That the accomplishment of Mr. George's purpose would be destructive to the best interests of the community.

It will be said that this is attempting a great deal in the space of one short magazine article, but let us see what can be done.

Now, it is true that labor does not create land, for land primarily comes from the hand of Nature, but then it is equally true that labor does not create gold, or silver, or coal, or timber, or grain, or wool, or any other of the primary gifts of Nature, commonly accounted in the market as wealth. Labor discovers, transports, cultivates, fashions, blends, makes useful in some way the free gifts of Nature, and they become wealth; labor also clears the land, drains it, fences it, fertilizes it, plants it, builds roads and bridges that make it accessible, and it becomes wealth. We find, therefore, at the very beginning of our quest, that land stands just where other kinds of property stand, and becomes wealth by certain processes similar to those by which movable substances become wealth.

But labor alone does not create wealth. Three things are necessary for the production or creation of material wealth: first, a natural product; second, the labor that fashions or utilizes it; third, *demand*.* Unless there is demand, unless the product that labor has brought into the market meets some want or gratifies some desire, the labor has gone for nothing. Hence it is not true that labor alone creates wealth. Nor does labor determine the measure of wealth. Whether I shall be well paid or ill paid for my labor depends upon its estimation in the market. I may labor many months in producing an article that can not be exchanged—that is, that does not sell; another man may labor no longer on something else that comes immediately into such demand that the maker thereof is enriched by it. Labor is always an indispensable factor in the production of wealth, but it is clear that it is not the sole factor.

That land is not wealth as it comes from the hands of Nature, but becomes wealth by human connection with it, is evident from the fact that wild land, when remote from civilized centers, has no price whatever. You can purchase in many parts of the world land enough for a kingdom at the price of a song; you can in some places appropriate a kingdom, if a wilderness makes a kingdom, by simply calling it your own. You can purchase land in Mexico for ten cents an acre, and it would not command even this almost nominal price were it not wanted for cattle-rearing. When we buy or sell land, the price paid is not for a mere stretch of earth, but either for improvements or conditions, for something given to the land by the efforts of man, or for something that has been developed in connection with the land as a consequence of man's relation to it. *Conditions* make the wealth that pertains to land, and it is always *conditions* that we buy and sell. And we do not always pay for or obtain the price in labor and capital that the conditions absolutely cost. Many pieces of cultivated land, not near the great towns, can be purchased at a price that is probably less than it cost to clear them, fence them, drain them, break up the sod, plant orchards upon them, and construct roads that lead to them. We talk about buying land just as we talk about buying coal, lumber, fish, minerals, grain, etc., when in all cases we buy labor, conditions, or rights, the land or the substances themselves being free from the hand of Nature. What is the price of coal in the mine, of lumber in the distant forest, of fish in the sea, of metals buried a thousand feet deep in the hills, of the phosphorus and other elements that combine to make us wheat and corn? Nothing. Coal in a mine situated for working or transportation a little more favorably than coal in other

* There are a few kinds of wealth that do not proceed from a natural product, such as patent-rights, copyrights, and productions in art. Macleod makes demand or exchangeability the sole test of wealth.

mines is worth a few cents a ton, perhaps ;* but coal in mines inaccessible by roads, in its absolute natural state, has no price whatsoever. When we buy fish we merely pay the fisherman for his labor. It is cheaper for us to do this than to go ourselves and catch the fish. When we require grain, or lumber, or wool, or cotton, we simply employ some one to do the work necessary for the production of grain, wool, or cotton, or for transporting the lumber to our door. Land, coal, the metals, etc., are therefore all alike—they are wealth by virtue of certain conditions ; they are not wealth in their natural state.

A community of ownership in land is demanded, and yet under our present social arrangement every man has his share of all that land produces. Land is occupied by one class of producers, but these producers do not enjoy its bounties one whit more than other classes do.† Practically, the land—confining ourselves for the present to agricultural land—is now as much the property of the community as it was when private ownership was unknown. With primitive peoples the possession of land is indispensable for existence. There are but two industries, the feeding of herds and the planting of corn, and the man or the tribe without land must needs perish. Civilization has brought about a very different state of things. The development of agriculture and the multiplication of industries have released a large body of workers from the soil. But the latter are by no means thereby cut off from the benefits of the land, for the products of their labor in other directions exchange freely for the products of the land, and secure for their enjoyment as much of these products as if they themselves had delved for the ore, planted the corn, or tended the herds. The world is not poorer, but richer, as a consequence of this separation of some part of human industry from the soil. If I am in possession of land I must labor on the land if I would enjoy its yield ; and if it is not in my possession I have still the privilege of enjoying its yield by paying some one else to perform the labor. As matters stand, I would rather pay Farmer Black for a bushel of potatoes than purchase and cultivate a garden in order to raise my own potatoes.

* I recall an instance of an owner of a coal-mine being paid for the privilege of working it six cents a ton for all that was mined.

† "Are there not bonanza mines, fortunes in petroleum, monopolies of metals and minerals?" will be asked. No rule can be made that does not have its temporary exceptions. Taking the silver and gold mines of the world during long periods, we will find that they have not paid their workers more than the average of profits that other forms of labor yield. If a man has a monopoly of any special product, he is enabled to tax his fellow-men to his own great advantage ; but the gratuities of Nature are so distributed over the world that monopolies are exceptional, and very rarely maintained beyond short periods. I generalize from common conditions, from the usual and ordinary operations of production. The demand for whale-oil may temporarily be so much more than the supply that those who hold the oil are enabled to command excessive profits ; but we can not argue from this that the whales in the sea are not common property—are not absolutely gratuities of Nature, conditions only determining the price of their product in the market.

If the truth were fairly told, I am afraid that the farmer who owns the land gets less for his labor in raising his potatoes than I, who own no land, get for my labor in obtaining the means whereby I am enabled to purchase the potatoes.*

In truth, we each of us obtain by the present social co-operative system a vast deal more of the bounties of Nature than we possibly could if in possession of land with nothing but our individual efforts to rely upon; and if we look the world over, we shall find that those communities enjoy the greatest abundance in which there is a great diversity of industry, an unrestricted accumulation of wealth, and where private ownership has been guaranteed by the authority of the state and supported by the consent of the people.

But private ownership of land is a monopoly, say Mr. George and his followers. Land belongs to the whole community; the state, therefore, should be the common landlord; and the first great step in a general act of readjustment is to appropriate the rental value of land by taxation. Improvements, it is magnanimously conceded, are not to be taxed; but land only to the full extent of its rental value. But what is the rental value of agricultural land apart from its improvements? According to Ricardo, all that land produces above the lowest point of production that will support the laborer goes, by virtue of the competition that always exists, to the landlord as rent. In this country freeholds are so general that we have little practical exemplification of the operation of the laws of rent; but, should the state become the common landlord, these laws would be sure to manifest themselves. According to this theory, if land yielding ten bushels to the acre is sufficient to subsist the worker thereon, then all land that yields more than ten bushels to the acre has a rental value equal to this excess. That is to say, the Georgeian plan of taxation, in so far as it affected agricultural lands, would, on all the farms of the country, absolutely *confiscate the entire results of labor above the mere point of subsistence.*

Ricardo's theory of rent may not be mathematically true, but it is unquestionably approximately true, because in the briskness of competition, in the struggle for subsistence, land must, if sought for at all, command a rental value proportionate to its yield above a certain minimum point. Mr. George will say that this is not what he means.

* The following statement, in a recent article by Edward Atkinson, illustrates how completely the product of the land falls to the benefit of the whole community: "One man working the equivalent of three hundred days in the year, or three men working one hundred days in the harvest-season on the far plains of Dakota in the production of wheat, aided by one man working three hundred days in milling and barreling the flour, and supplemented by two men working three hundred days in moving wheat and flour from Dakota to New York, and in keeping all the mechanism of the farm, the mill, and the railroad in good repair—four men's work for one year places one thousand barrels of flour at the mouth of the baker's oven in the city of New York—a yearly ration of bread for one thousand men and women."

It is no doubt true that he did not anticipate any such result, but is it not a logical consequence of a plan for seizing upon the rental value of land?

"But," say our land theorists, "land in favorable situations, and specially in or near great cities, brings enormous prices, not because of labor given to the land or of improvements built upon it, but for the reason that its situation makes it in demand and competition brings up the price. This land increased in value because of enterprises initiated often by persons not owners of the land, being an increase of value not due to the owner of the land, not because of anything he has planned or brought about, not as the result of his labor, skill, sagacity, or enterprise, but because of other people's labor, skill, and enterprise, and which becomes a tax that the community, as a whole, pays to the owner of the ground. Assuredly this is unjust. Why should men be allowed to grow enormously rich by lying still and simply retaining possession of their land?"

This is all true. I have spoken of value being due to labor or *conditions*, and here we have value that arises from demand, which is one form of conditions, just as the value of innumerable other things arises from demand. At first sight the position of the land theorists appears here to be very plausible; but there is nothing new in it. John Stuart Mill dwelt on the apparent injustice of what he calls unearned increment; but Mill saw that the appropriation by the state of this increment could not be accomplished without greatly disturbing the whole structure of society. He never even proposed a plan for the appropriation of this increase in the future, let alone of violently seizing upon a form of wealth that had grown up under the sanction of the laws.

But, after all, what is the difference between unearned increment in land and unearned increment in other kinds of property? All natural products are the bounty of Nature just as land is, and, like land, often yield to their possessors an unearned profit. Shall the Government compel all holders of wool, sugar, grain, iron, cotton, fish, lumber, and other products, to surrender through the machinery of a tax all profits that come from an increased demand for these articles? Unearned increment in products being often the result of conspiracies and schemes to the detriment of the public, its confiscation would be much more just than the confiscation of the increased value of land. The owner of land can not by his own personal efforts increase its value except by acts of advantage to the community—by building railroads, by erecting desirable buildings, by fostering industries; whereas the owner of products can not by his own personal efforts increase their value except by producing a "corner," by making them scarce, and thereby imposing a tax on consumers. Our theorists are really at war with a comparatively innocent form of unearned increment, but shut their eyes to a guilty form of it.

Unearned increment is commonly a direct tax upon society and undeniably is often an evil; but it is unavoidable so long as individual liberty and freedom of exchange exist, and can not be appropriated or even legislated upon without more evil arising than would be prevented. And then would not such an interference on the part of the state be an instance of a rule that should work both ways? If it is right for the Government to confiscate my profits on lands or goods when I am so fortunate as to make profits, it ought to make good my losses when my plans miscarry. If wheat or corn go up on my hands, and the tax-collector seizes upon the increase, shall I not be entitled to a bounty when corn and wheat on my hands go down? The new railroad has doubled the value of my lots in one town, but in another a diversion of trade and transportation in consequence thereof has nearly paralyzed everything, and my lots there are almost valueless. The state shall cheerfully have all the gain in one instance if it will make good the decline in the other. If unearned increment is proclaimed on one side of the reform banner, it should exhibit undeserved loss on the other.

But, assuming that there is some justice in the plan for appropriating unearned increase in the value of land, what would be the consequences if it were carried out? Mr. George does not propose compensation to owners for this arbitrary seizure of their wealth. Their property has been procured, under the sanction of the laws, by the general consent of the community and in reliance upon established usage, and hence its appropriation or confiscation under any plan would not only be grossly unjust, but it would destroy all sense of security in any kind of property, and fairly bring chaos itself upon us. Such a measure would be like a cyclone of the most destructive character through the length and breadth of the land. It would force into litigation every savings-bank, trust company, and life-insurance company in the country; it would cut off the revenue of innumerable institutions of learning and charity; it would rob millions of persons of their savings, impoverishing old age, young children, and dependent women; it would bring bankruptcy upon tens of thousands of traders, and impair credit everywhere. No class would suffer more than the poor, who hold in their savings through the savings-banks, liens amounting to thousands of millions upon landed property, much of which would be irretrievably lost.

And when all had been done, what would have been accomplished? Time would repair the damages and heal the wounds thus inflicted; but what compensation would there be? Mr. George declares that the nationalization of land would bring great blessings to struggling millions, but he does not anywhere show us how, or by what means. In his necromancy, private ownership of land and great poverty are here; community of land and general prosperity there; but we have not a word of explanation by what means a change of many landlords for one landlord is to bring about the splendid result he depicts. Taxation would fall on land, instead of, as now, on various forms of property, and this would be all. Doubtless, this would confer some benefit, but how is it to secure a juster distribution of profits, how is it to cause poverty to change its coat, and plenty come where want has hitherto existed? It is impossible to see how these results are to ensue, and the land theorists do not tell us.

The good that is pictured is a dream, whereas the evil would be immeasurable; and when we had all finally settled down to the new conditions, we should contemplate some such picture as the following: All the farm-lands in the country in a condition of shameful neglect, and their productiveness seriously decreased; state tenants going from farm to farm, cultivating the fields solely for their immediate yield, neither planting orchards, nor fertilizing, nor keeping in repair fences or drains. The ambition to improve would be paralyzed, and the desire to keep up the productiveness of the acres to a standard would no longer exist. As soon as one piece of land would be exhausted, the tenant would move to another. Every motive for careful cultivation and preservation would be replaced by motives for immediate profit. These conditions would follow any form of national ownership; but if George's tax of rental value were strictly enforced, there would be no inducement, as I have shown elsewhere in this article, to work the land at all. In towns and cities, or wherever land is used for commercial purposes, we should see rent paid just as it is now, but to the state instead of to individuals. The only difference would be, that all taxes would fall on land. Houses, bonds, mortgages, stocks, personal effects would be untaxed; that is to say, the greater part of most rich men's possessions would be unburdened, but rent would remain just as it is now, and enter into the price of commodities just as it does now. As the scheme is to tax up to the rental value, this rental value would be what competition and demand made it. Favorable situations would be bid for and go to the highest bidder, and consequently the poor would be pressed to the wall as much then as now.

Nor is this all. Under such an enormous enlargement of the powers of Government, jobbery and corruption would have a field for its operation such as the most sanguine Tweed never dreamed of. Our politicians would have all the corner lots, all the choice situations. And then, if the rents should prove to be in magnitude what Mr. George supposes, think of the funds that would lie in the state treasuries as tempting reserves for the schemes and devices of speculators and law-makers!

I have been able in the brief space allowed me to no more than roughly hint at all the possibilities involved in the startling scheme of the Georgeian economics. If it were possible to collect unearned increment, or to determine what it is and so adjust taxation that it should take just the increment and no more (which would be about as difficult as for Shylock to cut his pound of flesh and shed no blood), the gain thereby would be nothing to the tremendous injury to the whole people that would ensue? Can we increase the prosperity and well-being of a community by putting a penalty on success? Can a people advance under laws that check enterprise, that put a fine on sagacity, that repress energy, that destroy the liberty of the individual? There are possibly some evils that arise from private ownership of land, but the blessings that arise from it are simply incalculable. It is absurd to call it a monopoly; it is that only in name, in this country at least, where the land is really held by the people, and is always attainable by the people. We are peculiarly a landed democracy. Our farmers, for the most part, cultivate their own acres, and on every hill-side in the country stand innumerable cottages owned by their occupants and earned by labor and self-denial. The ownership of land is one of the greatest stimulants to right-doing that exists: it excites ambition; it promotes industry; it induces thrift and abstemious habits; it is the hope of youth and the pride of age. It is the very essence of wisdom to encourage it. Anarchy is impossible among a people wedded to the land. What if a few persons in the great cities become rich by the increase of the value of land—what is this to the welfare of the millions that have secured small footholds on the earth, and built their roof-trees? "I tell you what," says a French author, "those old fellows that invented marriage knew what they were about." So also, we may say, did those old fellows that invented private ownership of land.

FETICHISM OR ANTHROPOMORPHISM.

By GEORGE PELLEW.

IN the recent controversy between Mr. Spencer and Mr. Harrison on the subject of the relation between science and religion, the question of the historical priority of fetichism over spiritism or anthropomorphism was discussed at some length, and was somewhat dogmatically determined in the negative, by Mr. Spencer. Mr. Spencer, in his last contribution to the general controversy, cited a large number of authorities to support the position that all instances of fetichism are to be explained as the results of animism, namely, that a stone or a tree never has become an object of religious worship except as associated in some way with the notion of a ghost or a dream-spirit. The discussion was closed with this statement, and has not since been reopened. It may be, however, of interest to suggest some considerations which tend to show that Mr. Spencer's conclusion on this point was perhaps hasty and subject to revision, and that Mr. Harrison was possibly correct in asserting that the attitude of primitive men toward the universe must be supposed to have been fetichistic rather than anthropomorphic.

In attempting to ascertain the probable nature of primitive religion, no direct evidence, of course, is attainable. Man is now supposed to have existed upon the earth for perhaps more than fifty thousand years, and the earliest or most rudimentary beliefs known to have existed in historical times can be regarded only as survivals of thought in no respect necessarily primitive.

Arguments from the probable course of evolution, and various indirect arguments from analogy and from the application of ordinary common sense, furnish all the light that is possible on this question.

The simplest and most permanent element of religion in general is admitted to be a vague sense of wonder and awe in the presence of the external universe. Emotions of wonder and awe depend upon a consciousness of something mysterious or unexplained, and a consciousness of the lack of explanation can not arise until some perception has been gained of the relation of cause and effect.

The processes of evolution have been continuous, according to Mr. Spencer and modern men of science, from the inanimate world to man, or, at any rate, from the first speck of protoplasm that appeared on the earth's surface. With the first emergence of conscious perception on the earth of cause and effect, that is, practically, with the rise of reason as distinguished from instinct, must be placed the first beginning of the qualities or habits of thought or feeling that in time became religion. In an interesting essay on "Fetichism in Animals," Mr. Romanes has collected several instances of a sense of the mysterious, accompanied by wonder and awe or alarm in the higher animals. Of a like nature is the terror of a horse at the first sight of a steam-engine, of a dog at a person who makes unaccountable grimaces at it, and of most animals at the sound of thunder.

The sense of the mysterious, combined with instinctive or even conscious wonder and terror at unaccountable phenomena, can not, however, in itself be said to constitute religion. It is an element, but only one element, of religion. Even a sense of entire dependence upon external or higher powers would not, as Canon Liddon well said, be sufficient. "What is this power? That is a question which must be answered before feeling can determine its complexion."* The power to ask, much more the power to devise some answer to such a question as this, belongs clearly to a much later stage of evolution than does the simple perception of cause and effect that gives rise, as has been seen, to a sense of the mysterious. Phenomena must have been vaguely felt and contemplated, and from time to time wondered at, long before curiosity would be excited as to their nature; primitive savages would for ages observe natural movements without much intellectual curiosity, simply observing that the sun and moon moved, and animals and other things moved, without asking why they moved, but merely noticing and recording the fact of their motion.

The sense of the mysterious, which is one chief element of religion,

* H. P. Liddon, "Some Elements of Religion," London, 1873, p. 11.

would be excited clearly at first, not by the general order of Nature, not by familiar sights and sounds, but by unusual events, more especially by events occurring suddenly and attended or followed by danger or disaster; and it would not be until a spirit of curiosity was active that such events would be attempted to be explained. Curiosity is of late appearance in the course of mental evolution in animals, as Mr. Romanes has pointed out in his book on that subject: it is most marked in the family of apes, and must have been a principal factor in determining the development of human attributes in certain branches of that or a kindred family of primates. The natural operation of curiosity in those half-animal beings, when directed toward especially unaccountable cosmical events, would determine the nature of primitive religion. In what manner such curiosity would be satisfied can be approximately ascertained only by considering the mental operations that at that time had been evolved.

At the time in question, prior to the existence of definite language, reasoning could be little more than half-conscious, half-unconscious inferences from one set of objective phenomena to another, reasoning by analogy, of the crudest, baldest, most unscientific and unphilosophic form. This process of reasoning has its purely physical counterpart in the simplest reflex actions of the least developed organisms, that react in a similar manner to similar impressions. A Venus's fly-trap will clasp and inclose a little stone as well as a fly, although the fly only is digestible; and it is only by the gradual evolution of more and more delicate organs of sense and of nerves and nerve-centers of corresponding delicacy and complexity, that things apparently, but not really, alike come to be discriminated. The senses do not deceive, but it is the reasoning powers that fail, when a fish rises to a worsted fly, or a bird pecks at a painted cherry, or a little puppy barks and snaps at a rolling ball; and the method of reasoning, instinctive or conscious, is in each case the same, from similarity of appearance to similarity of cause. The basis of all reasoning is essentially the same, depending on the involuntary association of ideas, by which is simply meant the tendency when two ideas have once been associated in the mind for the first idea on its subsequent recurrence to recall the second idea, and *vice versa*. Similar habits of thought must have been normal among primitive men, largely instinctive, and unmodified by reflection. To the earliest men the movements of other men would seem to require no philosophical explanation, as to a dog the movements of another dog presumably seem to require none, except so far as their actions might seem indicative of hostility or assistance. To such men the movements of animals would be regarded as not different in kind from the actions of their fellow-men, and until they had learned better by experience or experiment they would tend to regard animals as not widely different from men, proper to coax or to blame, or if very strong and ferocious, to supplicate. In a similar way all moving things might naturally seem alive, agencies alike for good or evil, with powers mysterious indeed but not wholly dissimilar. Even inorganic things, stones and sticks, whatever may ever have been observed to move without apparent cause, might be supposed to be able to move, as animals might naturally be supposed to be able to talk. As the primitive man would urge on his half-tamed wolf or jackal to seize the deer or wild beast he was hunting, he would tend to caress or urge on the spear he threw or the bow he aimed; for, before subjective knowledge or abstract thought was possible, as soon as a thing moved, although the man pushed it, bent or threw it, it would become a moving thing, and seem to him to act as a living thing. The notion of a cause of motion, wholly independent of the moving thing, could not arise without greater power of abstract thinking than can be attributed to primitive men.

So soon as intelligent curiosity began to mingle with the dull wonder with which human beings had long regarded unusual natural events—such as, for instance, an eclipse, a flash of lightning, or a flood—the only explanations that could suggest themselves would be the logical result of the prevalent habits of thought, of such simple analogical reasoning as has been referred to. All moving things being vaguely felt to be living, the sun in eclipse would be thought of as sick or wounded; the lightning as a creature like a rattlesnake that makes a noise, glides swiftly, and strikes suddenly; the flood as the river itself in a rage or passion. Such vague explanations as these of the nature of the external universe, or of special events in it—explanations so little self-conscious and so little reasoned as hardly to deserve the name of "explanations"—would seem to be in the natural course of evolution the first notions that could be called religious; but such notions are pure fetichism. The characteristic of such a state of thought is, that the moving principle is not thought of as separate from the moving thing, nor the living principle as separate from the living being, nor the spirit of other men or animals as separate from their bodies. The observances appropriate to such a religion would consist in appeals to those external beings or imprecations upon them, similar to those appropriate between man and man, because those beings would be regarded as living and so not felt to be wholly different from men; but in every case the thing or object itself, and not anything unseen, would be the object of any ceremonial observance.

A community of children between the ages of two and five might naturally evolve a somewhat similar religious system. The baby who cries out, "Naughty door!" when it pinches its fingers in the hinges; the child who urges a spinning-top to continue spinning, or is angry with it for stopping; or who listens with wondering awe to a watch and asks if it is alive, long before any of them have any notion of spirit or ghost, or of unseen causes of action—all illustrate how naturally fetichism results from simple modes of thinking and reasoning. Similar habits of thought account for much of both ancient and modern mythology, without the intervention of spiritism; they appear as a revival in civilized nations in the astrology and alchemy of the middle ages, and may to-day be traced among many savage tribes. The Zuñis, for instance, observe that the rattlesnake makes a rattling noise, moves with rapid zigzag motion across the grass, strikes and kills suddenly. They notice that the lightning is succeeded by rattling thunder, that it moves with rapid zigzag motion across the sky, strikes and kills suddenly; they therefore call the lightning the brother of the rattlesnake, and they refrain from killing a rattlesnake for fear the lightning may strike them! It is plain that such a notion could have arisen without any conception of a spirit of the lightning distinct from the lightning, of a ghost or snakeship distinct from the snake. Similarly, the Zuñis speak of the rainbow as akin to the measuring-worm, because it appears after rain, and has a striped, arched back, and so forth. It is plain that such a notion could have also arisen without any conception of a rainbow-spirit or of a worm-spirit. If fetichism could have arisen without any connection with spiritism, it must scientifically be held to have so arisen, unless spiritism could have resulted from as early or from an earlier stage of thought.

While fetichism, however, could and naturally would result from purely analogical reasoning from one object to another, anthropomorphism or animism could possibly result only from reasoning of a much less simple character. It is essentially subjective, and involves considerable power of abstract thinking. It is subjective; since, before a savage could imagine unseen personalities as the cause of visible movement, he must have a notion of his own personality, distinct from his body, as the cause of his own movements. The notion of personality is an abstract idea that is peculiarly complex, and that is but slowly developed in conscious beings. Even a modern baby is supposed to attain the notion of "self" and the meaning of "I" and "me" but slowly, as is aptly described by the poet in "In Memoriam." It is clear that a general notion or abstract idea may be formed from objective perceptions much more easily than the simplest abstract idea that can result only from self-conscious reflection, and no number of purely objective perceptions could ever suggest the notion of "will," "cause," or "spirit," for there are no simple states of consciousness excited by sensation corresponding to such notions. It is unscientific, therefore, to assume that the earliest biped that could be called human rather than anthropoid possessed an innate intuition of personality, and if he had no such intuition, his crude notions about the nature of the universe could not have been anthropomorphic or animistic.

The simplest power of abstract thinking is, even by Mr. Romanes, denied to animals. It is generally admitted to be impossible without language, and language not in its simplest, most elementary form. It is unscientific, therefore, to ascribe such a power to primitive men in whom articulate speech was but just beginning to emerge from inarticulate noises and gestures. Even if, then, it were admitted, as Chauncey Wright suggested, that the notion of "will" and "personality" arose primarily from the objective observation of other men, since those ideas involve abstraction, it is yet unscientific to assert that the attitude of primitive men toward the universe was in any sense anthropomorphic.

Dream-spirits and ghosts may, indeed, have been the earliest *theory* to account, in a semi-scientific way, for cosmical movements and events; but, from an historical point of view, it would seem that phenomena must have been wondered at, and half-unconsciously classified, long before there was any attempt at any even partly coherent explanation of them. To prehistoric men the world must have seemed for ages, if the theory of evolution is accepted, as a mysterious jumble of half-living creatures, until it became partly intelligible as the theatre of the operation of a multitude of spirits. During those remote ages these strange creatures would themselves be the only possible objects of worship—and such worship would be properly termed fetichism—it could most certainly not be termed anthropomorphism or spiritism. Spiritism, when, with increasing intelligence and reasoning powers, it first began to be suggested, would have seemed almost like the revelation of a new religion, or like the discovery of a new scientific truth; older forms and notions would be retained, but with new meanings and new explanations, and the original meanings and explanations would be soon forgotten; but the beginnings of religion, unless the principle of continuity is discarded, must be sought for in the incoherent and fetichistic fancies that animism supplanted. There is some reason for believing that in recent times some such change from a simple analogical fetichism to animism has taken place among the Zuñis. It is asserted, for instance, that until lately they conceived of a bow as akin to a beast of prey, but that now they speak of it as inhabited or directed by the spirit of a deceased warrior.

The argument may now be summed up briefly as follows: Fetichism would naturally result from the simple objective observation and elementary analogical methods of reasoning that must have been characteristic of primitive men. Anthropomorphism involves a power of subjective introspection and of abstract thinking that can not have been possessed by primitive men. Between the earliest anthropomorphic conceptions of the universe of which we have record, and the simplest possible attitude toward the universe that could be described as in a rudimentary form religious, there must have been a long period of evolution—a period that may well have been measured by thousands of years—during which there may have been an indefinite number of gradations of religious sentiment and theory. During that period, then, there must have been some stages of thought, as an essential condition in the evolution of anthropomorphism, from the mild-eyed, incurious wonder of anthropoid apes or troglodytes that could be called by no other name than fetichism.

It may, at least, be said in conclusion, that the absence of extant evidence of such a stage of thought no more proves that it never existed than the absence of the bones of the missing link proves that men are not descended from non-human ancestors. All the negative evidence, then, that Mr. Spencer has so laboriously collected for the annihilation of Mr. Frederic Harrison, has no conclusive bearing on this question.

NOTE.—The conclusions of this article are confirmed by a variety of arguments and instances collected by Dr. Fritz Schultze, in "Fetichism: a Contribution to Anthropology and the History of Religion." Chapter III, on "The Relation between the Savage Mind and its Object," is of special value in this connection.

It may be further noticed that the evidences of fetichistic habits of thought among children are daily accumulating. In "Mind," vol. xli, page 150, for instance, Mr. E. M. Stevens relates the following anecdote of his son:

"He personifies the sun in an amusing way. One day, when he was about two years and two months old, he was sitting on the floor in a great temper over some trifle. He looked up and saw the sun through the window. He suddenly stopped crying, and said angrily, 'Sun *not* look at Hennie!' He said this two or three times, and then, finding the sun persistently looked at him, he changed his tone to one pathetically imploring, and said, '*Please*, Sun, not look at poor Hennie!' I have noticed this adjuration of the sun, when he has been crying, two or three times since." Is it to be supposed that this little two-year-old boy believed in a ghost or spirit, apart from and different from the bright sun that was dazzling his eyes?—G. P.

MISGOVERNMENT OF GREAT CITIES.

BY FRANK P. CRANDON.

[*Concluded.*]

SERIOUS as are the evils under which municipal governments are laboring, great as are the embarrassments growing out of our conservatism, the opposition of vested rights, and the clamor of charlatans and demagogues, to whom the establishment of a thoroughly honest and efficient government would be the loss of their entire stock in trade, and difficult of application as are the principles on which we must rest our plans, still I do not believe that the present situation is hopeless or remediless. I found my opinion on the conviction that a large majority of the people *desire* good government, and that, when the matter can be presented to them in an intelligible manner, they will give a cordial support to the measures by which it can be secured.

The first work, then, of those who are interested in the question of municipal reform is, after a thorough study of the subject, to formulate a system of city government which will secure all the legitimate results for which municipal governments are organized, while it reduces to the minimum the opportunities for official malfeasance.

I am informed that in Boston there is an association of gentlemen who are organized for this purpose. I would be glad to know that similar associations were formed in each of our great cities. Through such organizations the results of the most careful study might be generally disseminated, and the public thoroughly aroused. I would be glad to make some contribution to this general purpose, even if my offering be of insignificant value.

It is manifestly impracticable for me, in this paper, to treat of the details of the subject. Permit me, however, to suggest a few general principles which, it seems to me, must underlie any successful municipal structure, whatever be its form. And first I would announce, not at all as a new idea, but as one which can not be too often repeated, or too thoroughly emphasized, that *there must be a radical and a perpetual divorce between partisan politics and the management of municipal affairs.*

There is no natural connection between these interests. A municipal corporation is purely a business institution. It has to do with matters of sanitation, with sewers, pavements, docks, police, and public buildings. It maintains parks, and to some extent regulates railroad and gas companies, and provides the city with a supply of water. It collects and disburses the public revenue, establishes and maintains a fire-brigade, lights and cleans the streets, regulates and inspects the public markets. These and all other duties which are appropriately devolved upon the corporation demand, for their successful and efficient discharge, business tact and skill, honesty, and a fair share of common sense. There is no legitimate duty which a municipal officer will perform either better or worse because he is a Democrat, a Republican, or an Independent. There is no more reason for inquiring into the political sentiments of a mayor or any subordinate municipal officer than there is for asking as to the political preferences of a bank president, a railway president, or the members of the board of directors of either of such corporations.

The city government has no political functions. It can not determine any question of finance, or tariff, or domestic or foreign policy. It is merely a business agency for managing those specific affairs which have been placed in its care, and it will be most successful and efficient when it is administered by officers who are selected on account of their special adaptation to the work which they are expected to perform.

In our country, political party preferences are frequently so strong as to control votes in favor of a candidate notoriously unfit for the position for which he has been named. The voter feels that he owes his fealty to his party irrespective of the merits or demerits of that party's candidates, and this sentiment of the voter is utilized by the office-seekers to secure a support which they could not otherwise obtain.

Not unfrequently the canvass which precedes a municipal election is simply an appeal to political preferences and party associations. The real issue, to wit, the honesty and capacity of the several candidates to discharge the duties of the offices to which they aspire, receive next to no consideration, and in the end the success of party candidates is esteemed a fitting occasion for congratulations and rejoicing, even when the effect is to displace efficient officers by those who are inefficient.

The elimination of partisan politics from municipal affairs would be an important and a significant reform. To the place-hunters and spoilsmen of politics it would be an official "notice to quit," and it would mean that the municipal constituency had determined that the administration of city affairs should be conducted on business principles. It would help to make it practicable to secure and retain good men in the public service.

It is not often that those gentlemen, whose services either in the Council or in the executive departments of the city government are most to be desired, will undertake to secure a nomination and election through the use of the regular party machinery. The prerequisite manipulation, and the self-abasement and humiliation, which generally attend a successful candidature, demand more patriotism and self-sacrifice than even good men ordinarily possess. It is difficult to see why any man who ought to be elected should so earnestly desire the position of councilman or alderman in the city government as to be willing to pay for it what it costs in time, money, and self-respect when it comes to him as the result of a political party nomination.

When obtained, it only offers an opportunity for appropriating to the public interests a large amount of time and gratuitous service. Its only compensation must be that which comes from a sense of having faithfully and honestly discharged a duty. This is hardly sufficiently inspiring to attract the best men to the public service.

Mr. Shorey, in the pamphlet already referred to, in discussing another topic, says: "An instance will illustrate what I mean: Last spring an educated gentleman in the First Ward had faithfully served the public interests in the City Council for six years. He was not at all anxious to continue in the public service, and very properly refused to make any personal exertion to secure a renomination. The business men of that ward, in which there is probably two hundred million dollars' worth of property, paid little or no attention to the matter, and the result was the loss of an excellent representative of the character and intelligence of the city in the Council."

This is a case directly apposite to my argument. The successor to the councilman, whose loss to the Council Mr. Shorey deprecates, was the proprietor of a miserable groggery, who secured the party nomination.

Experience in former discussions leads me to anticipate here an objection which may be formulated thus: "Admitting all that you urge as to the evils of party politics in municipal affairs, and also as to the desirability of such a divorce as you suggest, there still remains the fact that they can not be separated."

The validity of this objection I am in no wise prepared to admit. It assumes that the mass of the people are indifferent to the matter of good government, and that the voters of any municipality have more regard for an intangible, ineffectual, inoperative political success than they have for the correct and efficient management of city affairs.

I do not believe that this is true. It will *seem* to be true so long as municipal elections are handed over to professional politicians and ward-bummers for management. But let the prominent and influential gentlemen in all political parties unite in an effort to elect only the best men to municipal positions; let them present only candidates of recognized ability and character; let the people be made to realize that there is absolutely no political principle involved in the contest, and the voters can not then be controlled by professional political leaders.

We are not without illustrations of the truth of this theory. In New York the good people of all political parties united for the overthrow of the Tweed dynasty, as they did in Philadelphia to depose McManes, and as they have since done in Cincinnati, and as they once did in Chicago. Under proper management these occasional and spasmodic exhibitions of non-political elections may become the rule rather than the exception, as applied to municipal governments. They tend to demonstrate the fact that the public sentiment, when properly aroused, will not tolerate official mismanagement and corruption.

Looking to this end, municipal elections should be made to occur at dates as remote as possible from those fixed for national and State elections, so that there may be the least possible complications with outside issues, and the least temptation to quote these elections as indices of political sentiment.

But more than to anything else, and, in my judgment, more than to all things else, the misgovernment of our great cities is chargeable *to our practically unrestricted suffrage.* I say *unrestricted,* because the facility with which all regulations as to naturalization and registration are evaded makes it comparatively an easy matter for any individual to vote at least once at any election.

Those cities which are constantly receiving a large influx of foreign immigration, which is both ignorant and impoverished, are the greatest sufferers, but all municipalities are placed in jeopardy by this irresponsible and unintelligent suffrage. I do not enter the lists as an opponent of what is termed "manhood suffrage" when applied to State and national elections, that is, when applied to the determination of political questions. But neither the same nor similar conditions can be predicated of municipal corporations.

I restate a proposition which has already been emphasized in this discussion, to wit, *that the municipality is a business corporation.* It may not be strictly analogous to a corporation operated for private interests, such as a great railway company or a manufacturing establishment. But that it is far more nearly allied to one of these than it is to any political institution will not, I think, be seriously disputed.

It is a joint-stock affair in which the tax-payers are the stockholders, and to them substantially should the management of its business be committed. I am aware that this proposition will be criticised as undemocratic and anti-American, but I am none the less convinced that it is logical and worthy of support.

Subtract from the body of electors that element which would be eliminated by the application of this principle, and such a dynasty as that of Tweed and Sweeney in New York, McManes in Philadelphia, and Carter Harrison in Chicago, would be an absolute impossibility.

The substratum of all ring-rule in municipal affairs is that suffrage which is subject to manipulation and purchase by adroit and unprincipled managers, and which by artful appeals may be induced to regard all property-owners as natural enemies.

The present city government of Chicago owes its existence in a large measure to the immunity that has been extended to gamblers, thieves, tramps, thugs, and communists, who, in consequence of this immunity, rally to the support of our present mayor at every election, and resort to every species of fraud in his behalf. In return, they are permitted to ply their nefarious vocations practically unmolested.

No sane man doubts that the votes of the tax-payers of Chicago would elect an entirely different class of city officers—officers who would administer the government in the interests of good citizens rather than in the interests of the criminal classes. This being admitted, is it possible that there can be any question as to which policy ought to prevail?

I do not want to be understood as including the entire non-taxpaying classes in one group, or as making any sweeping assertions which would apply to them indiscriminately. On the contrary, I know very well that many of them are among our best citizens, and entirely worthy of the public confidence and respect. I would willingly consent to any scheme which would put all good citizens in the voting class, and all doubtful or unworthy citizens into the ranks of the non-voters. I am, however, unable to devise any system which will more nearly accomplish this than the one which I have suggested, and I am unable to see how it works any hardship to any one.

None of the rights or liberties of the non-tax-paying citizen would be imperiled by his inability to vote at municipal elections. The powers of the corporation can not be legitimately exercised to his damage. If they are illegitimately so exercised, then the courts are open to his protection, and will be found vastly more efficient for that purpose than would be the power to vote.

And why is it not safe as well as equitable to commit the management of the business of the corporation to the stockholders—the tax-payers? They are the parties most directly and positively interested.

All kinds of improvements, the maintenance of good order, the security and protection of life and property, affect them more vitally than they affect other citizens. Would not a fire department which would be satisfactory to the owners of warehouses, banks, hotels, offices, commercial establishments, and costly private residences, be entirely adequate to the needs of those who own no buildings? Would not a police establishment which would serve to protect the public and private property of any large city and all its tax-paying inhabitants, necessarily be sufficient to meet all the necessities of the rest of the community?

In the matters of improving streets, and the laying out and ornamenting of drives and parks, would not the improvements made by the owners of property as a means of enhancing its value, as well as for the purposes of personal enjoyment, be a satisfactory provision for the use and comfort of those citizens who were not asked to contribute toward the expense of making them?

In many cities the cost of all such improvements as sewers, pavements, sidewalks, street-lamps, boulevards, and water-mains is charged directly on the abutting property, and are only constructed when petitioned for by a majority of the property-owners who will be called upon to pay for them. In all such cases the very existence of these improvements is a sufficient answer to the objection that public improvements would be impeded by an administration elected by taxpayers.

Indeed, it is reasonable to expect that the very opposite would be true, and that, with the assurance that public works would be managed with honesty and economy, the sentiment in favor of their construction would constantly increase.

There are two interests which I think it is probable that non-taxpaying citizens would be unwilling should be left entirely in the hands of their tax-paying neighbors. I refer to the provisions to be made for general education, and the proper and sufficient care of the poor.

I do not personally feel that even these interests would thus be in any degree jeopardized. They might, however, be so guarded and protected in the organic act of incorporation as to be placed absolutely beyond any danger.

What would be the result if, in our great railway corporations and large manufacturing companies, the board of directors, instead of being chosen by the stockholders, were to be elected by the employés? What would be the relative probability of securing a competent and efficient management? There could be but one outcome to such a policy: stockholders and employés would soon be involved in one common ruin. Query, Can the municipal corporation, acting under a similar policy, escape a like disaster?

But here, again, I expect to meet the objection once before noticed, viz., that the plan, whatever be its merits, is an impracticable one.

It will be said that where the elective franchise has once been conceded it can not be recalled. I recognize the difficulties of the situation, but I do not admit that they are insurmountable.

Instances are numerous where guards, limitations, and restrictions have been imposed upon the elective franchise by legislative authority, and it is but taking another step in this direction to establish the principle which I have been advocating.

No one will dispute that it is entirely competent for the Legislature, when organizing municipal corporations, to prescribe the conditions under which the elective franchise shall be exercised. If, then, the legislators should come to approve this method, it could readily be applied in erecting future municipalities.

In the case of cities like Boston, St. Louis, Cincinnati, etc., where there are two legislative bodies in the city government, we might, perhaps, make one of them elective by the popular vote, and the other by a vote of the tax-payers only. It might be required that appropriation bills and bills for raising the revenue should receive the approval of both bodies. Then, by-and by, when the people shall have come to the conclusion that only one legislative body is needful, they might decide to retain the one elected by the tax-payers and abolish the other.

Or, without in any way interfering with the right of suffrage in the case of any one who is now a voter, it might be determined as to any one who is not now a voter, that he shall not hereafter be entitled to the municipal franchise unless he be a tax-payer.

If the principle be correct, as I believe it to be, and if it be accepted by thoughtful men as one of the conditions of honest government, the *method* by which it may be incorporated into the municipal system will be devised. The method which has just been adopted by Chicago for securing fair elections will doubtless help to correct many of the evils which arise from what I have characterized as an *unrestricted suffrage.* The operations of this new election machinery will be watched with great interest by all who take an interest in municipal affairs, and it may be that from this source our deliverance is to come.

I notice one other particular in which reform in municipal governments is imperatively demanded: that is, *the consideration which is given to the needs of the proletariat.* The truth of the aphorism, "No man liveth to himself," more and more imposes itself on the attention of thoughtful men. It is a truth which neither individuals nor aggregations of individuals can afford to ignore.

The first problem in social science ever submitted for consideration was, "Am I my brother's keeper?" It would seem as if ever since that time the world had been endeavoring to find a negative answer to the question. No such answer has been found. No such answer can ever be found, because the law of reciprocal obligation is always operative in society. Evade the subject as we may; put it aside and refuse to consider it, as so many do; characterize it as Utopian, or sophistical, or chimerical—nevertheless it constantly reasserts itself with the declaration, "The voice of thy brother's blood crieth unto me from the ground."

We may wrap ourselves in a mantle of selfish exclusiveness and refuse to recognize these obligations, but ever and anon the jostling of passing events will remind us of neglected duties.

Our responsibilities in this regard are not confined to legal formalities nor bounded by them. They have to do with our relations as members of one common brotherhood. Our employés have claims upon us in addition to the stipulated compensation for services rendered and our recognition of their technical rights—claims upon our sympathy with their sufferings and misfortunes; claims to our encouragement in all their efforts for improvement, and to our helpful care in every time of need.

The claims of our neighbors who are not our employés are equally valid and imperious. Personal interest, as well as our obligations as good citizens and honest men, forbid us to ignore these claims. There is a tendency prevalent in society to limit these obligations by the narrowest possible lines.

Men look askance at the various manifestations of evil in the community, and, instead of planning and working for the correction of the evil, they spend their thoughts and efforts in devising better safeguards for their personal interests, in the vain hope that, when the storm does come, their defenses will be found sufficient. When the ruin comes, however, the strong and the weak are involved in one common catastrophe.

The granger organizations which a few years ago wrought such disaster to the railway interests of the Northwest, the strikes prevalent in connection with mining and manufacturing industries, and the riotous demonstrations and destructive agencies of the commune, serve as illustrations.

We were lately receiving the details of what was termed the working-men's insurrection in London. We see how easily such a movement passes under the control of socialistic and communistic leaders, and how readily it is transformed from a popular demand for employment into an ungovernable and devastating mob.

Doubtless a large fraction of this assemblage was made up of the criminal and base elements of society, but another large fraction was composed of those who had neither bread nor an opportunity to earn it—men who would be peaceable and industrious if only they could be given a chance to provide food for themselves and for those dependent upon them.

It was the discontent and sense of wrong upon the part of this element that made the riot possible. I am very far from offering any justification for such demonstrations, or excusing such acts of destruction or violence. But I want to call attention to this source of danger and menace to the good order and peace of society, and the security of property. An unemployed and more than half-starved element in any community is a slumbering volcano which at any moment is liable to a violent and destructive excitement. In the rapine and desolation that follow such an eruption, we see the result of ignoring the obligations to which I have referred—obligations, indeed, that are not recognized by our laws, and such as can not be enforced in any of our courts, but which are of a character that transcend all human law, and reside in that relationship which the Creator has established between men.

Take away the conditions of suffering and want which are coincident with an unemployed laboring class, and both the pretext and incentive to such demonstrations will be wanting.

But hungry men are neither philosophers nor political economists. Both themselves and those who depend upon them are in the direst need. Food and wealth are plentiful, but in the midst of both they are dying from want. Is it strange that under the promptings of their necessities they come to regard wealth as their enemy, and its possessors as in league against them, or that they determine to obtain relief without reference to the legal rights of those who may for the time being be the owners of that which they so much need?

We deprecate these outbursts. They ought to receive the severest condemnation. Their effect can only be to aggravate the very difficulties by which they are inspired. But let us remember that they have their origin, to a very considerable extent, in the indifference of society to its obligations to the laboring classes, and that society can only be made secure by recognizing and discharging these obligations.

The recent labor-strikes, culminating in the dynamite murders at Haymarket Square, in Chicago, should not, in my judgment, be classed with the London demonstration.

The labor difficulties occurring throughout the United States, in the first half of A. D. 1886, have a different purpose and origin. They are the first manifestations of a plan to establish an oligarchy of workmen. A secret organization was established, on the theory of unquestioning obedience to the mandates of its leaders. Its members were made to believe that the organization was potent and beneficent. Under the pretense of protecting labor, these leaders assumed to dictate and control the actions of laborers, after a fashion more odious and tyrannical than was ever before known among civilized men. Large numbers of working-men were deceived by the professions of these demagogical leaders. Others were intimidated and dragooned by the power of the organization, and thus these pestilent fellows of the basest sort were enabled for the time to set at defiance all law, to trample upon all rights of property and person, and institute a reign of anarchy and destruction.

The spirit of revolution and disorder pervaded the whole movement, and justified the most prompt and aggressive action on the part of the police and military authorities. It is to be hoped that the civil law, in the legitimate exercise of its power, may permanently relieve society from the presence of these leading anarchists.

The municipality, too, is charged with certain obligations to its proletariat. On the proper discharge of these obligations, the contentment, sobriety, and good citizenship of the community will very largely depend. Among other things, it ought to be the care of the city that the houses built for the accommodation of this population are suitably constructed, with a due regard to the health and comfort of the inmates; that the streets where they live are properly lighted, and sewered, and cleaned; that they have an ample supply of pure water; that public baths are established for their use; that libraries and reading-rooms are established for all who will use them; that public parks are established, with some reference to the convenience and comfort of this part of the people; and that some simple entertainment, such as music in the parks, be furnished for them.

The expense both of time and money which might be involved in carrying out these and such other plans as would be instituted in behalf of this part of the city's population, would afford the most ample returns, even when considered as an investment. It would lessen the amount of disorder and crime. It would reduce the demands made upon the hospital and poor-relief funds, and it would increase the value of taxable property.

There would be no quarter of the city which was practically assigned to the criminal and degraded classes—no localities which would have the reputation of the Old Five Points of New York, or the Levee of Chicago. I do not mean that we should in this way remove all destitution, degradation, or crime, but that we would reduce these evils to their smallest dimensions; that we would advance every material and social interest of the city, and would discharge a duty that is devolved upon us by the claims of humanity, the instincts of self-interest, and the principles of the wisest political economy.

FULGURITES, OR LIGHTNING-HOLES.

By GEORGE P. MERRILL.

THE peculiar and often disastrous results attendant upon an electric discharge have been dwelt upon since time immemorial. To even briefly refer to the numerous recorded instances of the destruction of life and property by the discharge of "heaven's artillery" would far exceed the limits of this paper. It is my purpose, therefore, to call attention only to those peculiarly interesting, though usually quite harmless, effects produced by the lightning striking in loose sand; though, before closing, I shall allude to the closely allied phenomena resulting from similar discharges upon solid rock. In the sand, as is well known, the usual result produced is that of fusion, whereby a frail, glassy tube of variable diameter and length is produced, the interior of which is a true amorphous glass, quite smooth, while exteriorly it is roughly granular and greatly corrugated. Such are called *fulgurites* or *fulmination-tubes* in English, while, to the German and French, they are known as *Blitzröhren* and *tubes fulminaires* respectively.

So far as can be learned from available literature, the earliest description to be made of these peculiar objects was that of Pastor David Hermann in 1711. According to Gilbert,* this gentleman, as early as 1706 and 1707, dug from a sand-hill in Massel, Silesia, fulgurites some twenty feet in length, which he very fully described in his work on Massel and its curiosities.

Hermann's account is curious and full of interest, as his statements concerning the origin of the tubes were the purest guess-work, and his views regarding them wild in the extreme. He designated them by the name "Osteocolla," and proposed to use them for medicinal purposes, as will be noted later.

The earliest account of an occurrence of this kind, where the fusion was indubitably proved to be due to lightning, is that of Mr. Withering, in the "Transactions of the Philosophical Society of London for 1790." In the narrative as there given, a man, who had taken refuge beneath a tree at Aylesford, England, during a thunder-storm, was instantly killed and his clothing set fire from a flash of lightning, which first struck the upper portion of the tree and thence passed downward toward the ground. A portion of the electric fluid, after leaving the man's body, passed down a walking-stick held in his hand and thence to the ground, where it made a hole some two and a half inches in diameter. The first ten inches of this hole presented nothing worthy of remark; at this point, however, the fluid was found to have followed along for some eight inches the root of a tree which presented itself, and which, aside from a slight superficial blackening, was unharmed. Some closely adjacent quartz-pebbles did not, however, escape so easily, but were found with their corners and angles very considerably rounded by fusion. The hole was traced only to a depth of about eighteen inches, and no real tube is mentioned as having been discovered.

The next account which we have to notice is that given by Dr. Fiedler,† who describes in detail the finding of fulgurites by Dr. Hentzen and others in the great sand-wastes of Paderborn, common-

* "Ann. der Physik.," B. 61, 1819, p. 249.

† Ibid., vol. lv, 1817, p. 121.

ly called Senne. He also describes them as having been found in similar situations in Pillau, near Königsberg, in Prussia ; at Nietleben, near Halle ; and at Drigg, in Cumberland, England. In a subsequent paper, two years later,* he further describes other tubes found at Rheine, in the bishopric of Münster, in Prussia ; the sand-hills of Regenstein, near Blankenburg, in the Harz; and near Bahia, in Brazil. Fiedler is followed in his turn by Gilbert, † who gives a history of the finding of the fulgurite at Massel, as above noted, and also those of Bahia, in Brazil. An excellent *résumé* of the matter up to 1821 is given in the "Ann. de Chemie et de Physique" for that year, ‡ and also brief descriptions of the fulgurites formed on solid rock, as described by Saussure and Humboldt.

The tubes found in Cumberland were three in number, and were formed in a white and reddish quartz-sand, in which were a few pebbles of "hornstone porphyry." One of the tubes was followed down to a depth of twenty-nine feet, where it came in contact with a fragment of the porphyry, and glanced off at an angle of about forty-five degrees. The surface of the porphyry fragment was somewhat fused, forming an olive-green glass. Beyond the fragment, the tube resumed its vertical direction, but became weaker and easily broken. The caving-in of the sand prevented exploration to a greater depth. One of these tubes was two-pronged, and the main branch was again divided into two, while small, lateral branches, two or three inches long, were given off at intervals.

The account of the occurrence and appearance of the tubes found at Massel, as given by Hermann in 1811, and as quoted by Gilbert, is as entertaining as it is inaccurate. He says: "The glass-like tube resembles molten glass or iron. It grows in yellow sand from the depth of the earth at Massel, on the south side of the Töpel Hill, and also in the Ellgutten wood, and on the high sand-hills close to the village of Klein Schweinern. The tube has sometimes the thickness of a finger or a thumb ; at other times it is as thick as a quill-pen, and the deeper one goes, the thicker and stronger it is found (?). Its constituent parts are very soft when underground, but soon become hard by exposure to the air, and have the appearance of a gritty, ash, or iron-colored enamel, glisten like crystal at the point of fracture, give a clear, ringing sound, and cut glass. It is hollow, shines like glass, and has a reddish-brown color. It is not found near the surface, but only after digging several ells into the ground. In the months of May or June it naturally pushes upward, and crops out of the sand. This point afterward breaks off of its own accord, or is knocked off by the feet of passing people, cattle, or vehicles, by means of which many a beautiful piece is found" (?).

* "Ann. der Physik.," vol. lxi, 1819, p. 235. † Ibid., vol. lxi, 1819, p. 249.

‡ "Sur des tubes Vitreux qui paraissent products par des comps de foudre." "Ann. Chem.," etc., p. 290.

Passing by, for lack of space, the interesting accounts given by Darwin * and Fiedler † of fulgurites found at Maldonado, near the mouth of the La Plata, in South America, and in a vineyard on the right bank of the river Elbe, and simply noting the finding of similar tubes at Northfield Farms, Massachusetts, in 1861, ‡ we will mention the next recorded occurrence at Macclesfield, England, # which, like that of Cumberland, is remarkable on account of the length of the tube found. This is described as three fourths of an inch in diameter at its upper end, and tapering gradually throughout its length to within three or four feet of its lower end, where it assumed a slanting direction, and then divided into several filaments or branches, and became dispersed and obliterated in the soft, spongy soil. This fulgurite was traced to a depth of twenty-two feet in a straight line, and gives us a good illustration of the immense heat and power of penetration of an electric discharge.

The occurrence described by Roemer,‖ of twenty-five sets of fulgurite tubes, within a space of one hundred by two hundred yards in the great sand-flats of Starczynow in Poland, is, I believe, the most remarkable on record. The sand in this case was a very pure quartz-sand with a few pebbles of rolled flint ("Feuerstein").

The tubes were found with their upper ends exposed, owing to the blowing away of the loose sand, and varied in size from the thickness of one's arm to that of a wooden knitting-needle, while the thickness of the tube-wall varied from one to two millimetres, rarely more.

An article by the present writer △ gives a detailed description of fulgurites from Santa Rosa Island, Florida; Sumter, South Carolina; and Union Grove, Illinois, now in the collections of the National Museum.

Those from Santa Rosa were formed by the lightning striking a small pine-tree, and thence descending to the ground, where, at a distance of about forty feet from the trunk it formed a tube, which occurred as a crooked, irregular line along the surface. This was nearly pure glass, grayish in color, translucent, and very free from corrugations, though in some cases completely collapsed. The small fragments of the tube from Sumter, South Carolina, were found while digging a well at a depth of twenty feet below the surface. The tube-walls were very thick and strong, brownish and opaque. They lacked the corrugations, but had, externally, rather the knotted appearance compared by Gümbel to that of stag's horns. The great amount of material received from Union Grove, Illinois, shows this to be proba-

* "Voyage of H. M. S. Beagle."

† "Comptes Rendus," vol. xvii, 1843, p. 216.

‡ "American Journal of Science," vol. xxxi, p. 302.

"Geological Magazine." 1865.

‖ "Neues Jahrbuch für Mineralogie," etc., 1876.

△ Shortly to appear in "Proceedings of the National Museum," vol. ix, 1886. This article gives also a very full bibliography of the subject.

bly the most extensive find of fulgurites yet noted in this country. The locality where they occurred is the top of a sand-hill some fifty feet square. Several sets or pairs of tubes were found here, but a few inches apart, together with several small, irregular masses of fused material, the largest of which weighed several ounces. The largest tube found was about three and a half inches in diameter, but was too frail to remove. The accompanying plate shows the characteristic forms.

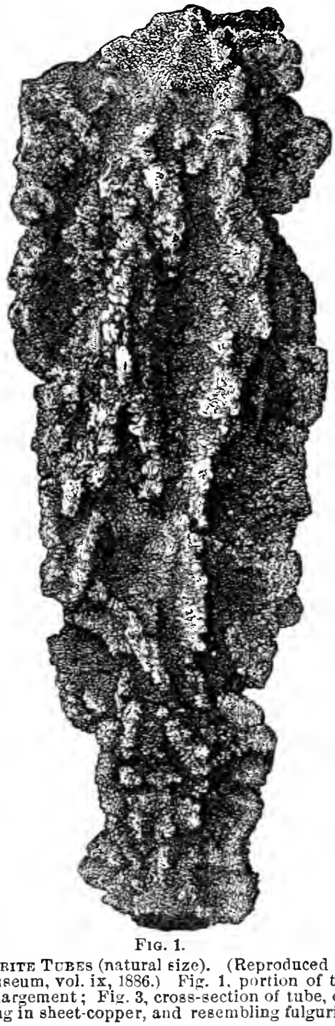


Fig. 1.

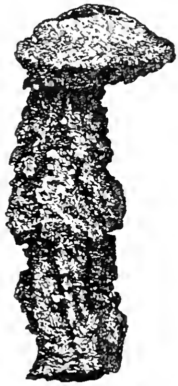


Fig. 2.

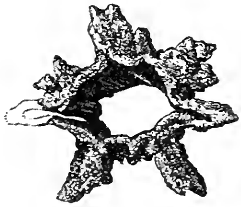


Fig. 3.

Fig. 4.

Fulgurite Tubes (natural size). (Reproduced from Proceedings of the United States National Museum, vol. ix, 1886.) Fig. 1, portion of tube, common form; Fig. 2, tube with bulb-like enlargement; Fig. 3, cross-section of tube, characteristic form; Fig. 4, holes fused by lightning in sheet-copper, and resembling fulgurite tubes in outline.

One of these was traced into the sand for a distance of about seven feet, and was found to increase in size slightly from above downward. They were frequently branched, and often sent out small, nearly flat horizontal branches or shoots, about one quarter of an inch wide, and half as thick, the greater diameter being horizontal. The hole in these was quite small, and closed abruptly at the end. Fig. 2 is peculiarly striking, and seems quite different in form from any yet described. These "bulbs" are said to correspond with the stratification in the sand.

Concerning the microscopic and chemical properties of the fulgurite, little seems to have been done until within a comparatively recent period. In 1875, Harting* examined some fulgurites found in a corn-field at Elspeet. He describes these as vitrified tubes, having a form scoriaceous, rough, and very irregular. Exteriorly they were coated with sand and carbonaceous particles, while interiorly they were of a white glass which was sometimes streaked with brown or black, a coloration which he judges to be due to distillation products from the vegetable matter in the sand. A complete chemical analysis of the fulgurite yielded results as follows: SiO_2, 90·2 per cent; Al_2O_3, 0·9 per cent; Fe_2O_3, 0.7 per cent; CaO, 0·1 per cent; MgO, 0·5 per cent; K_2O, 0·5 per cent; NaO, 0·6 per cent; insoluble in HCl, 0·9 per cent; carbonaceous matter, 5·6 per cent.

Discussing the results, the author argues that the alkalies and other bases, belonging to the vegetable matter, have been driven off by the heat of the flash, since the percentages shown are not greater than is contained by the sand itself. He also conceives that the presence of these bases may have aided in the reduction of the refractory silica—an idea which seems to have also been adopted by Gümbel and Wichmann. When, however, we consider the extraordinary brief duration of the flash and heat, this reaction seems scarcely possible.

Gümbel † describes fulgurites from the Libyan Desert between Dachel and the Ammon Oasis, in which the tube-wall consists of an amorphous glass enveloping unfused quartz-kernels. A partial chemical analysis led him to conclude the interior lining to be a true *quartz* glass. To this conclusion Wichmann ‡ takes exceptions. This gentleman pulverized portions of the fulgurite tubes from Senner Heide, from Elspeet, and from Starczynow, and by means of a solution of great density # succeeded in separating the glass of the fulgurite from the inclosed sand. Chemical analysis of this yielded silica as follows:

Senner Heide	96·44 per cent.
Elspeet	94·26 " "
Starczynow	91·23 " "

* "Annales des Mines," vol. viii, 1875, p. 700.

† "Zeit. der deutsch. geol. Gesell.," vol. xxxv, p. 648.

‡ "Zeit. der deutsch. geol. Gesell.," vol. xxxv, p. 849.

The solution in common use by lithologists, for separating finely powdered minerals of different specific gravities, is a saturated solution of the iodides of mercury and potassium. Properly prepared this can be brought to a density sufficient to float any substance of specific gravity not greater than 3·25. By gradually diluting the solution and thus rendering it less dense, it is possible to separate the various minerals of a powdered rock with a considerable degree of accuracy.

Thus proving that the glass was not a pure *quartz* glass. Owing to the small amount of material at his disposal, the other constituents could not be determined.

As viewed in their sections under the microscope, this glass was completely amorphous, showing only a few partially fused grains on the outer portion. There were no traces of crystallization products from the fused magma, the duration of the heat and the cooling following being too brief and too rapid for their productions. It was, however, filled with cavities of varying sizes, formed by the volatilization of the moisture in the sand at the time of the formation of the tube.

In the paper by the present writer, already referred to, the composition of both the fulgurite glass and the sand in which they formed is given as follows:

CONSTITUENTS.	Glass.	Sand.
	Per cent.	Per cent.
Ignition	0·33	1·00
Silica	91·66	84·83
Oxides of iron and aluminium	6·69	9·88
Calcium oxide	0·38	1·16
Magnesium oxide	0 12	0·13
Potassium oxide	0·73	1·13
Sodium oxide	0·77	1·15
Total	100·68	99·64

Thus proving conclusively that, in this case at least, the glass was not a pure quartz glass, although it showed itself to be richer in silica than the sand from which it originated—a result which, to say the least, was hardly expected.

Discussing the results of the above analyses, the writer concludes that the composition of the fulgurite glass is dependent entirely upon the conducting power of the various mineral constituents of the sand, regardless of their fusibility; that the glass, showing a larger proportion of silica than the sand in which it forms, points to the fusion of the siliceous (i. e., the quartz) grains, in preference to the feldspathic and ferruginous; hence, that the quartz-grains were poorer conductors of the electric fluid than were the others. This may, perhaps, be in part accounted for from the fact that the feldspar-grains were partially kaolinized, and hence held more moisture, which would render them better conductors.

It is not at all strange that at first many opinions prevailed regarding the nature and origin of the fulgurite tubes, and that some of these were peculiar in the extreme. Pastor Hermann seems to have gone farthest astray, for he says: "This growth (i. e., the fulgurite) is undoubtedly the product of a subterranean fire, whereby not only this tube is formed through melting sand, *accedente viscoso quodam fucco*, but also the two springs at Massel and Ellgutt, between which this tube is found, are warmed by the same fire."

As already noted, he designated the fulgurites by the name of *vitrified Osteocalla*, or *Ostecolla Masselsis*, and proposed to utilize them for medicinal purposes, placing them in the same category as deer-horns, crab's eyes and corals, which at that time were considered as excellent for all kinds of "fevers, virulent and febrile diseases." The finding of the molten quartz directly in the track of the lightning at Aylesford, England, as described in the "Philosophical Journal" noted, was accepted as proof positive of the electric origin of fulgurites by Fiedler and most others. Nevertheless, Dr. Clark, of Cambridge, in one of his public lectures in the year 1816, took occasion to deny this method of origin regarding the fulgurites of Drigg, and contended that they were but concretionary forms lined interiorly with a mineral resembling hyalite or pearl sinter. Dr. Fiedler fully discusses all possible source of origin, including the probability of their being incrustations on roots, sinters, or other mineral products, or aggregates of ancient sea-worms, and finally proves, apparently conclusively, their origin from electric fusion, an origin concerning which there can at present be no doubt.

The cause of the frequent occurrence of fulgurite in sandy plains, which seemingly present but little attractive force to the electric fluid, has been frequently discussed. Fiedler ascribed it to the fact that at certain depths below the surface there are little portions of water, and the tubes are produced by the passage of the fluid from the surface to these portions, where it becomes neutralized. Darwin, writing of the Maldonado fulgurites, thinks it probable that in that particular instance the flash divided into two or more branches before entering the ground, rather than that they were formed by several distinct discharges. To the present writer, the explanation suggested by Roemer, regarding the extraordinary find at Starczynow, seems most probable. Here it will be remembered that some twenty-five tubes were found in a space one hundred by two hundred yards. Roemer calls attention to the fact that these may have been formed at intervals of even hundreds of years; also to the equally important fact that the lightning, although striking with the same frequency in less exposed places, might fail to produce the tubes, owing to the character of the soil, or, if so produced, they would be obscured by leaves, soil, etc., instead of having their upper ends exposed by the drifting away of the sand.

The deeply corrugated, or winged, and otherwise peculiar form of the fulgurite tubes, has been a matter of some speculation. Darwin, as already noted, considered it to be due to the pressure of the sand acting while the tubes were still plastic—a view which has been in many cases adopted by subsequent writers. Fiedler and Harting, on the other hand, considered that the size and form of the tube, or, in other words, the shape of the bore of the lightning, was largely dependent upon the vapor engendered from the water in the sand at the time of the flash. Indeed, these authorities considered the presence of water in the sand as essential to the formation of the tube. Wichmann does not fully acquiesce in the view that the wings are produced by the collapsing of a portion of the tube-walls, but considers them as original formations.

That they are not due simply to collapsing is the opinion of the present writer. In the article quoted he there expresses the opinion that the irregular form of the tube near the surface is due to the exceeding energetic action of the current during this part of its course, and the lack of homogeneity in the conducting material. At depths of a few feet below the surface, where the force of the current had become to some extent reduced, and the sand was more compact and homogeneous, the tube was found more nearly cylindrical.* It is very probable that steam may have been instrumental in producing the bulb-like enlargements so commonly found, but it can scarcely be considered as essential to the formation of the tube itself.

We have next to notice the fulgurites produced upon solid rock. These, as can readily be imagined, differ from those produced in the sand, in being of but slight depth, and frequently existing merely as a thin, glassy coating on the surface.

G. Rose † describes fulgurites of this nature as occurring in abundance upon the summit of Little Ararat, in Armenia. The rock is an andesite, somewhat soft and porous, and it is stated that blocks a foot long can be obtained, perforated in all directions by the irregular tubes, from three to five centimetres in diameter, which are filled with a bottle-green glass, formed from the fused rock.

A small specimen of this rock, deposited in the National Museum,‡ has much the appearance of a rock bored by the teredo, the holes in which have subsequently been filled by the green glass. It is stated by this writer that, in fulgurites collected by Humboldt from the Punta del Fraile, in Mexico, the fused mass of the walls had overflowed the tubes upon the surrounding surfaces. Saussure describes fulgurites as occurring also in the hornblendic schists of Mont Blanc, and Ramond mentions similar occurrences on Monts Perdu and Pic du Midi in the Pyrenees, as well as upon Mont Auvergne in France.#

Wichmann ‖ examined the Ararat fulgurite glass with the microscope, and found it to agree closely with that of those formed in loose sand, being completely amorphous without trace of microlites, and in containing numerous steam cavities.

* He also shows that, even in so homogeneous a material as sheet-copper, the hole produced by electric fusion is not in all cases circular in outline, but is often quite irregular, closely resembling a cross-section of fulgurite tube. (See Fig. 4 of plate.)

† "Zeit. der deutsch. geol. Gesell," vol. xxv, p. 112.

‡ The property of Mr. J. S. Diller.

"Ann. de Chim. et Physique," Bd. xix, p. 155.

‖ "Zeit. der deutsch. geol. Gesell.," vol. xxxv, p. 858.

Dr. Gilbert describes* the fulgurites found by Humboldt upon the high peaks of the Nevada de Toluca, in Mexico. The rock on which they were found is described as a *trap porphyry* taken from the summit of the Pic del Fraile at a height of 2,364 "toisen" (about 4,621 metres). Masses some two feet square are said to occur covered with a thin layer (about one half of a millimetre) of a pistacio-green glass. In one instance, where a feldspar crystal intervened, the glass was white. The peculiar shimmer of this glass in the sun led Humboldt to ascend this precipitous peak even at the risk of his life. In many places the rock was completely pierced by small cylindrical tubes, which were lined with the same greenish glass, and this was found to resemble closely the glass from the inner walls of the tubes found at the Senner Heide.

The most interesting and, so far as I am aware, the only investigation of this kind undertaken in America is that of Mr. J. S. Diller on fulgurite from Mount Thielson, in Oregon.† The summit of this mountain is described as being composed of a hypersthene basalt, very precipitous and difficult of ascent. The fulgurite occurs both as a superficial coating on the rock, and in the form of tubes. "Although spread over a considerable surface, it is not evenly distributed, but is arranged in patches of drops and bubbles of glass in very much the same way as paint which has been put upon a greasy surface." The glass is described as translucent and of a greenish color. In places the tube penetrated the rock to a depth of a few inches, having a diameter of from 10·5 to 20 millimetres. These have a glassy lining of some two millimetres in thickness. The tubes are not regarded as having been produced by the lightning itself, but to be pre-existing tubes and cavities (the rock is naturally spongy), into which the fluid passed and fused the walls. The chemical composition of this glass was found to be silica, 55·04 per cent; alumina and iron, 28·99 per cent; lime, 7·86 per cent; magnesia, 5·85 per cent; potash and soda not determined; loss by ignition, 1·11 per cent; total, 98·85 per cent. This was also found to be practically the composition of the groundmass, or non-crystalline portion of the rock.

The fulgurite found on the summit of Dom du Gonte, one of the peaks forming a part of the chain of Mont Blanc, has been recently described by Rutley.‡ The rock is represented as a hornblendic gneiss. The fused material formed merely a superficial coating in the form of attached globules or irregularly fused pellets and blotches of brownish, black, or white glass. The white glass resulting from the fusion of the feldspar, while the dark in like manner was of hornblendic origin. This occurrence of the two glasses, unmixed even

* "Ann. der Physik.," B. 61, 1819, pp. 261 and 315. See also "Ann. de Chim. et de Physique," pp. 281 and 299.

† "Am. Jour. Sci.," vol. xxviii, October, 1884, p. 252.

‡ "Quar. Jour. Geol. Soc.," vol. xli, 1885, p. 152.

when in actual contact, well illustrates the extreme rapidity of the whole proceeding, "the fused surface of each mineral having cooled almost exactly *in situ*." In nearly every other particular the observations made on the glass corresponded with those above noted.

In conclusion, it may be said that a careful examination of high, isolated mountain-peaks and areas of loose drifting sand will doubtless result in the discovery of many more of these interesting phenomena than have yet been reported.

VIEWS OF LIFE IN THE CRAZY MOUNTAINS.

By Mrs. E. D. W. HATCH.

SOME months ago, looking in the direction of the foot-hills, I saw a "jack-rabbit" making its long leaps toward its home, white as the snow around it; but for its sudden springs in the air, it would hardly have been distinguished from the earth's covering.

By a curious provision of Nature, this animal, much larger than the common rabbit, changes its color in cold weather, in common with some others, and with some classes of birds. This is not the case with animals that hibernate, or slumber through the winter, as the bears. The change of color seems to act as a safeguard to protect the animals from their natural enemies. The coyote likewise becomes nearly white in winter, or very light colored. The antelope is also much lighter in these northern latitudes in winter. A *white* deer was killed in Yellowstone Park last December; this absence of color was probably due to a freak of Nature. The jack-rabbit often retains color in its ears when the rest of its body is entirly white. A smaller species of rabbit, commonly called the "cotton-tail," does not change. Besides the animals already mentioned as having this property, five or six species are similarly peculiar—the ermine, weasel, and hare; the latter somewhat differing from the jack-rabbit. Of the feathered creation the ptarmigan, a species of grouse, shifts its summer clothing for light feathers in the winter. Wolves have been uncommonly plentiful during the last season; why, when there are so many more hunters, is hard to say, unless it is that their larder is better supplied by so much additional stock being in the Territory. The strategy of these wolves is remarkable. That they have, in common with many other animals, some method of communicating with each other, and laying plans, is evident. Many a band of horses loses largely by their wounding and carrying off young colts. A young colt, however, is rather a stupid, staring sort of an animal—not blessed with ordinary animal presence of mind, or obedient enough nature, to heed maternal warnings and escape with the rest of the flying band when the wolves attack them. These ferocious animals will hang around a lot of cows, and making selection of one, two, or three of them, will go in front of the cow, and by fierce attack seek to separate her from her calf and distract her attention, while others sneak behind and disable or kill the calf. If the cow is a good fighter and drives them away from the wounded calf, they bide their time until she is obliged to go for a drink or food, and then have a feast upon veal. Their method of chasing the antelope shows that they understand well the habits of different animals. An antelope when running takes a circle of two or three miles, and then returns to the starting-point. So the wolves combine and establish relays (as it were) on this circle: the first leaders running the frightened animals half a mile, perhaps, they drop out, and the next relay does the same, and thus by relays they worry the antelope until it falls exhausted; they then give a peculiar cry or bark, a summons which calls the pack together to the feast. It is a fine sight to look upon a number of antelopes running freely across the hills, now out of sight in a hollow, then leaping, heads up, over the ridge, showing enjoyment in every motion. Often, when one is out riding, they will run parallel to the road, or the carriage, a long way. They are not wise animals, and often fall victims to their curiosity. A red rag on a stick thrust in the ground, or some other small object attracts them: they stop to look, get closer to investigate, and are thus brought within gunshot of the wily hunter lying in ambush who prepared the decoy. There was a time, on the ranch, when we were subject to the depredations of some animal carrying destruction among the sheep after they were put up for the night in one of the corrals near the hills. This corral, in which one of the "bands" was inclosed, was about four miles from the house, the herder in charge having a cabin close by. The dogs did not make the usual disturbance, but seemed completely cowed when the robber was about. This sign, as well as some others, seemed to indicate that the foe was a mountain-lion. The creature kept carefully out of sight, but managed to raid at night, with much destruction; so the owners and herders in turn mounted guard at night, armed. The wary creature did not approach the inclosure while it was thus guarded, but it was evident he was near, though never seeming to come by the same path twice, and watching the guard. One of the men left his post at daylight, but before sunrise the enemy seized the advantage and killed a sheep for his breakfast. Another morning the herder having been on guard, went in for his morning meal, thinking all safe. Hearing a suspicious sound he sprang to the door, and opened it, but too late, as the form of a beast disappeared in the brush. After a little time a light snow fell, and an endeavor was made to track the unknown. Following up the mountain-side at length, upon a hill, in rather a secluded, rocky place, commanding a good lookout, the beast's lair seemed to be found, but he was not at home. Poisoned meat was several times placed conveniently for him, but, though it seemed sometimes to have been carried away, it was plain he did not taste it, as he still did his own slaughtering when there was opportunity, and the shots fired into the brush never hit him. At length, however, he must have been tempted, and poison beginning its work, Mr. Lion made his last leap into the corral, killed two sheep, and died by their side. The men placed him in a wagon and brought him to the house for exhibition. He measured nine feet from the tip of his nose to the end of his tail, and had a cat-shaped head and ears, tremendous paws, and a dull-yellow color. It is said the mountain-lions of the Black Hills are striped with white, particularly on the face, but this was not the case with the one of which I write, the only one I have ever seen. It seems a misnomer to call this creature a lion, even with the prefix mountain. He does not have a den, but "lies around" wherever he can make himself comfortable, sometimes living chiefly in an abandoned "*wickey-up*," a deserted shanty in the brush, among the rocks, or in a "coolie," and always on the watch. It is said they will not attack a person unless cornered, but I think one who trusted this certificate of character might have cause to repent. Stealthy animals with such characteristics are not to be trusted. *Our* lion, set up by a taxidermist, was one of the attractions of the park last summer, and is probably one of the largest specimens of his race. Sheep-owners have much to contend with in this part of the country, and wild animals seem to have ways of their own, with a ready adaptation of habits of mischief to circumstances. The home corral outside the yard fence, and but a little way from the house, contained at one time some two thousand sheep. There was a fence around it, as well as about the house. Temporarily a few valuable sheep were placed at night in the yard. The bears came down at night, like the Assyrians of old, but instead of going to the outside corral, which was far the handiest for them, they boldly under cover of the darkness, came into the yard. The dogs gave the alarm, waking every one on the place, but, before the men could get out, the bears had killed seven sheep, and it seemed in pure wantonness mangled others so that they afterward died. It was rather an uncommon thing for these animals to venture so near a house.

The sheep-dogs deserve more than a passing mention. Their intelligence and quick apprehension of what is required of them, and faithful performance of duty, are wonderful; without them, the working force for sheep would require to be more than doubled. They appreciate kind treatment, and take to heart scolding and abuse. No surly or cross man to the dogs should be allowed among sheep. A foreman of a sheep-ranch told me that, in sending out a new man, he assigned an old dog to him, thinking, if the man did not know his duty, the dog did. He charged the would-be herder to be kind to the dog, and said, "He will not stay with you if you are not." In two days the dog was at home again. The foreman visited the man, taking another dog, and said to him: "You were cross to the old dog, and I told you he would not stand it; you can't get along without a dog." "I was not cross to the dog; but, confound him, he would not even let me *swear at the sheep!*"

When spring approaches we are reminded that even here, in the rocky hills and desert-lands of sage-brush, cactus, and alkali-springs, Nature is not sparing of her gifts, and these arid hills and plains show forth many floral beauties.

Among them is one that claims universal admiration when seen in flower, belonging to the primrose family, said to be named for its discoverer, Lewis the explorer, *Lewisnia*, growing wild in the sand and gravel of the rocky ledges of the foot-hills, mostly on the southern side. The leaves are coarse, radical, and from four to eight inches long. The root stretches several feet, fleshy and red, with two or three side or lateral roots. It may be that this plant is the same as that mentioned in a report to the United States Agricultural Department among the "Food-products of the North American Indians in California," called in the report *Lewesia rediviva*, and by the Indians "spatulum." The root of this plant is described as large and spindle-shaped, its inner part white and farinaceous; and the report continues: "It abounds in concentrated nutriment, a single ounce of the dried article being sufficient for a meal. It is worthy of cultivation." Perhaps, being cultivated, it might take rank with the potato. It has rare floral beauty; the buds spring from the crown of the root, the leaves of the plant spreading around flat on the ground; the buds grow nearly upright, from one to two inches in length. If you watch them about sundown, you can see the buds slowly expand, and soon open into a pure white flower, four- and five-petaled, rose-scented, containing long stamens and pistils covered with pollen. The flower expanding near nightfall, such a pure and delicate white, changes gradually next morning, as the sun comes up, to a light rose-pink, afterward becoming a deep pink; and the old blossom then closes, lies down, and falls off. Although these plants are found in the poorest of dry soil and rocky ledges, where they would seem to get no moisture, or very little, yet a lady friend who successfully transplanted them, says: "We planted them in the garden, bottom-land, along a creek, and there they grew larger and more beautiful, flowering freely until frost. On one plant of two years' growth I counted twenty or more buds." They have many seeds; seed-pod four-celled, about an inch long, fleshy at base and tapering up.

The absence of wild fruit or nut-bearing trees and shrubs is a noticeable drawback, but perhaps is not at all remarkable, the lands requiring irrigation for fruit or produce.

As far as the writer's observation extends, there is but one good fruit growing here: that is the red raspberry, in the mountains; large, hardy, and more finely flavored than the choice raspberries in the States.

I have been told of the buffalo-berry, but it can not be plenty or very choice, from accounts.

On the creeks there is a good gooseberry, and in low grounds the black- or choke-cherry ; of these, native jellies are made ; but ye highly favored, abundant-fruit people, can you imagine choke-cherries a luxury? Yea, verily, to us in desert-lands they are.

MASSAGE.

By Lady JOHN MANNERS.

IN the present day, when we hear so much of the wear and tear of daily work and worry, and when the preservation and restoration of health are of supreme importance to those who take the foremost rank in the battle of life, it may not be unprofitable to cast a glance on the means employed by the nations of the Orient and of antiquity to develop and maintain the vigor of the body.

The history of massage, which of late years has been employed with wonderful success as a cure for many ailments, has been written by Dr. Hünerfauth, of Homburg, and, in the hope that some hints may be useful, I have translated extracts from his comprehensive work.

The expression "massage" is derived, according to Pierry ("Dictionary of Medical Science"), from a Greek word signifying "to rub" ; according to Savary ("Letters on Egypt"), its derivation is from the Arabic word "mass," to press softly. In England a process of somewhat the same character is known as shampooing. It seems certain that massage was practiced by the Indians and the Chinese many centuries before the birth of our Saviour. It was combined with hygienic gymnastics. The Brahmans exercised the art of healing ; the priests of Buddha are known to have acquired much of their power over their people by their skill in medicine. Sir William Jones, the great Oriental linguist, discovered fragments of the third sacred book of the Brahman period, entitled "The Knowledge of Life," which contained many secrets of Indian medicine. An extract from Dally's work states that, when Alexander the Great penetrated as far as India, in the year 337 before Christ, his soldiers suffered much from the bites of serpents, for which no cure was known by the Greeks. Alexander had gathered round him the best Indian doctors, and he proclaimed to the army that any who had been bitten must come to the royal tent to be cured. These Indian doctors were in great repute ; illnesses were not of frequent occurrence in those delightful climates, but any who were sick resorted to the wise men, or Brahmans, who cured them by wonderful or, as they professed, supernatural means. It has been ascertained that massage and shampooing were among the remedies employed by them.

The "Law of Manu" prescribed diet, washing, baths, rubbing, and anointing with oil as religious exercises.

In 1854 an account was published of a German merchant, who had been treated in Stockholm by medical gymnastics, and who made a journey to Calcutta, and went through a course of massage and exercises there, in order to become an authority on the subject. He afterward founded an athenæum for rational gymnastics in Berlin.

The gymnastic exercises of the Indians consist of (1) wrestling, (2) of what we should call boxing, (3) stick, or sword, exercise. They also practice movements for rendering the limbs supple, and manipulations of various sorts. Before the Indians begin their exercises, they cower on the earth, and by turns rub each other with the mud from the delta of the Ganges when they can obtain it. All the muscles of their bodies are pressed and kneaded. When Indians are unwell, they frequently employ a cure called *chamboning:* the whole of the patient's body is gently kneaded, beginning with the upper extremities, descending to the feet.

Dr. Stein, of Heidelberg, who spent some years in the Dutch medical service in Java, writes that massage is practiced there, as in almost all the Dutch colonies of the Indian Ocean. It is known as *pidjet-ten*, and it is also employed in the Society, Sandwich, Feejee, and Tonga Islands. Dr. Emerson, a native of the Sandwich Islands, says it is there called *lomi-lomi*, and is performed either over the whole or part of the body, usually by old women. It consists in rubbing and kneading, and may vary from the gentlest stroke to the most powerful grip. It is considered as a high mark of honor for a host to perform this operation for his guest, or to receive this attention from him. No pain is inflicted. Occasionally the natives lie flat on the earth, and let their children trample on them. In an account of the Isle of Tonga, it is related that, when people are suffering from great fatigue, three or four little children are employed to trample on the body of the patient as he lies on the grass. Massage is frequently applied to the forehead, or the top of the head, in those islands, with excellent results.

In Forster's account of Cook's travels in Tahiti, we read that the friendly inhabitants rubbed the travelers' limbs in order to refresh them after their fatigues.

The Chinese are supposed to have learned the use of gymnastic exercises from the Indians, and the subject was mentioned in the most ancient of their books, the "Cong-Fou," or "Science of Living." The Chinese added the use of medicinal plants to the treatment of illness by rubbing and gymnastic exercises. The Egyptians were and are proficients in the art of manipulation, anointing with oil and friction being part of the cure employed. The Greeks employed gymnastics and massage in order to preserve health as well as to restore it.

Pythagoras taught his disciples to practice moderation, to use vegetable diet and gymnastic exercises.

The gymnasiums and palæstriums of the Greeks were famous. Plato writes, "The object of gymnasiums is to instruct youths and men how to preserve health and keep their frames in good condition."

Before the Greeks took part in the national games, they had to undergo a course of preparation—bathing, friction, anointing, and also rubbing with sand. Fine sand from the Nile was preferred, and was imported from Egypt for the purpose; there were many rules for carrying out the process properly, and it was performed in various ways.

Among the many editions of the works of Hippocrates, there is a French one by Littré, in which the following passage occurs:

"A physician must possess experience of many subjects, among others, of massage."

Among the Romans, as, indeed, every child knows, the constant use of baths, followed by friction and anointing with oil, was customary. In illness, rubbing with warm oil, other kinds of friction, and "movement-cures," were used. Asclepiades also recommended exercise and friction. Celsus, the author of eight books on the science of healing, took for his motto, "The best medicine is to take no medicine." In inflammation of the brain, if he wished to induce sleep, he ordered rubbing for a considerable time (would this be animal magnetism?). He also advises rubbing to cure acute pains in the head, though not during an attack, and recommends friction to strengthen weak limbs.

Celsus lays much stress on passive movement for invalids. "The gentlest is exercise in voyaging on a ship, either in harbor or on a river. If being driven in a carriage is too fatiguing, he recommends the invalid to be carried on a couch or in a chair, and advises that the patient should be rocked in bed if too feeble to rise. Galen, who lived in the second century after Christ, approved highly of massage and gymnastics, but he did not advise athletics. He ordered friction in the evening, to remove fatigue. The body was to be rubbed with a woolen cloth, afterward with oil till the surface became red, and then with the bare hands in various directions. Rufus of Ephesus, who lived in the reign of Trajan, writes, "Women and maidens should sing and dance, not only to do honor to the gods, but in order to preserve their health." He adds, "It is important that physicians should not confine their attention to the bodily health, but should do all they can to develop the mental strength and well-being of children and young people, of men, and even of old men."

We must pass over notices of many treatises that appeared during the fifteenth and sixteenth centuries, only remarking that Hoffman, in 1708, seems to have advocated the principles that govern the German schools of gymnastics in the nineteenth century.

Hoffman wrote that the conditions under which health is to be maintained are simple: exercise of various kinds, in alternation with rest, cold water, and strict attention to diet. One of his maxims was, that "work and tiring exercise are universal panaceas."

Between the years 1756 and 1786, Tronchin, a scholar of Boerhaave's, was in great repute in Paris; he was physician to the Duke of Orleans and to Voltaire, and it was owing to his advice that Voltaire went to live at Ferney. People came to consult him from distant countries; his success was extraordinary. His system consisted in ordering friction, movements of various characters, exercise, long walks, and certain precautions in diet.

Fuller wrote, about the same period, on the value of exercise in the cure of various illnesses, and especially in hypochondriacal and hysterical affections. He also laid great stress on riding; indeed, he established a riding-cure, which had great success among very distinguished persons. Tissot, of Lausanne, wrote a treatise on the health of the learned, strongly impressing on the studious and sedentary the duty of exercise; he advises games of billiards, ball, shuttlecock, hunting, shooting, swimming, wrestling, dancing, leaping, riding, walking, traveling, exercising the voice, speaking, reading aloud, declaiming, and singing. Here Dr. Hünerfauth remarks that many great physicians in old times considered reading aloud, declaiming, and singing highly beneficial to the general health. Plutarch mentions that daily exercise of the voice conduces greatly to health.

A system of gymnastics was established in Sweden by Peter Ling, between 1805 and 1839. He was the son of a pastor, and devoted his life to the study of exercises for the development of the human frame. Swedish exercises are much used now in England.

Massage and gymnastic exercises have more votaries in France than in England. The love of sport that seems inherent in English people is supposed to have obviated the necessity for a widely extended system of gymnastics. Now, however, gymnastic exercises and musical drill are being introduced largely, and have been much appreciated, not only by men and boys, but by women and girls.

The system of massage practiced by Dr. Metzger has drawn crowds to Amsterdam, and has afforded relief to great numbers of sufferers, several reigning sovereigns—among others the Empress of Austria—being among his patients. Dr. Hünerfauth carries out the same system at Homburg with equal success, and a member of his family devotes much of her time to relieving from charity the sufferings of the peasants.

It is necessary to beware of masseurs who have no real knowledge of the art, as disastrous results follow from the violent treatment to which ignorant persons subject their patients. Dr. Hünerfauth deprecates massage by machinery, as he considers that much delicacy is necessary in treating the complicated nervous system of the human frame. It is curious to find how much benefit many sufferers derive from a revival of the same remedies practiced in by-gone ages and in distant climes. Truly, there is nothing new under the sun.

It has occurred to me that women might, after being properly instructed, find the practice of massage a useful and profitable employment. I believe the usual time employed at one sitting is from twenty minutes to half an hour. To relieve, for instance, the oppression produced by irregularity of the action of the heart, gentle continuous rubbing would be practiced for ten minutes from the left to the right side in a downward direction, then from right to left. The patient should lie on a reclining board, and the masseuse stand so as to be able to rub firmly, though without inflicting the least pain. To calm nervous agitation and to induce sleep, it has been found that rubbing the spine is an almost certain remedy, and sufferers from neuralgia have often derived great benefit from massage.

Friction with pine-oil is a favorite cure for rheumatic affections in Germany, and also for bronchial and throat complaints. The aromatic, astringent fragrance of the oil, which is made from resinous portions of the fir-trees, has a salutary effect in pulmonary cases.

I happened lately to read an account of an institute in London whence "masseurs" are sent to private houses. I know nothing of the system carried out there, but I see that four guineas a week is the charge for daily visits at the patient's own house.

Such an expense would be out of the question for most people, as a course of massage should be continued for six weeks or two months. Indeed, there are many invalids, of great position and wealth, who have a masseuse attached to their households. Doubtless there are numbers of women who would gladly practice this healing art for moderate remuneration, and find much happiness in soothing pain and relieving weariness.—*Nineteenth Century.*

SKETCH OF CHARLES C. ABBOTT.

THE name of Dr. Abbott is familiar to the readers of the "Monthly" as that of the author of papers showing him to be on the best of terms with Nature, as well as of an archæologist who finds history where ordinary diggers would find only gravel and river-shells. It is as well known to readers of other periodicals in America and England, who are interested in the moving and the blooming life of the fields and the woods and the rivers. He has been making friends by means of his charming sketches, and the books that have resulted from them, till he now probably numbers all of the English-speaking world, who appreciate rural things, among his constituency. What remained wanting to fix his fame and make it general was given by his last book, "Upland and Meadow," of which the English critic, James Purves, pronouncing it "the most delightful book of its kind which America has given us," and declaring that "it closely approaches White's 'Selborne,'" only gave formal expression to the thought which arose in the mind of every reader.

Charles Conrad Abbott was born June 4, 1843, in Trenton, New Jersey, the third son of Timothy Abbott and Susan Conrad. He is of Quaker descent on both sides. His paternal ancestor came from England in 1680, and his maternal ancestor, Dennis Conrad, the founder of Germantown, Pennsylvania, from Germany at about the same time.

Until nearly the present time the family (Abbotts) remained Quakers, in three generations only two marriages with others than Quakers having taken place. Dr. Abbott's own sympathies are with the Hicksite or Unitarian branch of that denomination.

Although no naturalist among the Abbotts of Burlington County, New Jersey, appeared in earlier generations, it is a somewhat significant fact that a fondness for such studies was so marked as to lead to a long intimacy with the Bartrams of Philadelphia, when the naturalists John and William (father and son) were living, and the celebrated Bartram's garden on the Schuylkill was kept up.

Young Abbott himself exhibited a very strong liking for natural history at an early age, and never was afraid of living animals of any kind. This fearlessness resulted frequently in stings, bites, and scratches by the creatures which, too often, were rudely handled. These tastes were probably an inherited trait, derived from his maternal grandfather, Solomon W. Conrad, at one time lecturer on botany and mineralogy at the University of Pennsylvania.

From 1852 to 1858, inclusive, Abbott attended the Trenton Academy, then a good classical school, but under strict theological control, where anything savoring of science, even zoölogy, was frowned upon as likely to produce direful spiritual results. Indeed, Abbott was once punished for asserting that a whale was not a fish, the teacher insisting that it was, "on the authority of Scripture." Rebellion against such ignorance kept Abbott in ill-favor with the faculty, and practically little knowledge worth the having was acquired. But, as an offset to this, every Saturday and Sunday was wholly taken up with out-door studies of the fauna of the neighborhood. The gatherings of these "two-day" tramps were usually brought home alive, and the frequent escape of snakes, lizards, and snapping-turtles, not only in the yard, but in the house, necessitated some restrictions upon his methods of study, which, however, were usually circumvented, and the obnoxious creatures kept turning up in many unsuspected localities.

When, on the approach of manhood, the vital question of business or a profession came up, the nearest approach to Abbott's tastes was the study of medicine, and it was commenced in a half-hearted way in 1860. The choice of a preceptor was more happy in a zoölogical than in a medical point of view, and the result was that teacher and student were "two boys together," discussing the woods and meadows rather more assiduously than human anatomy.

Often, in fact, text-books were laid aside for months, to give undivided attention to the fauna of the Delaware River Valley. The wide-reaching meadows, tangled swamps, and stretches of woodland on his grandfather's farm formed, collectively, the college from which it was Abbott's ambition to graduate.

The result of this untrained field-work, during 1860–'63 was a series of papers on the habits of mammals, birds, batrachians, and fishes, which were presented to a learned society for publication, and rejected, on the ground of the improbability of a *boy* having been able to discover so much that was not already in the writings of authors, and also because some of the observations were in many ways contradictory of them.

Young Abbott's career as an author began in 1859 with a note concerning migratory birds, which was published in the "State Gazette," of Trenton, as his maiden effort. This was followed by a short series of ornithological sketches in the same paper. In 1860 he published brief communications on fishes in the "Proceedings" of the Academy of Natural Sciences of Philadelphia, and an account of the habits of the curious pirate perch (*Aphrodederus sayanus*).

The manuscripts of the rejected papers were preserved, and, in subsequent years, the later generation of naturalists verified, in their field-work, the results claimed to have been obtained by Abbott. Without detracting from the credit which is justly due to them as independent observers and discoverers, it is proper to say that Abbott would have forestalled much of recent work in the study of the habits of animals had his papers, when presented, been accepted.

In 1865 Abbott was graduated in the medical department of the University of Pennsylvania. He was married in 1867, and from that time, except for a brief interval, when engaged in manufacturing chemicals, he has devoted himself to scientific study and general literature. In 1874 he came into possession of the Abbott homestead, and was thus better enabled than before to prosecute his studies, in the pursuit of which he has spent days and nights also in the field, and has thus enjoyed the opportunity of studying the objects of his inquiries in all the situations and aspects of their life; and then it was that, more systematically than ever, he undertook those exhaustive archæological investigations which have been so fruitful of results, and have associated him so closely with the Peabody Museum of Archæology at Cambridge, Massachusetts, of which institution he has been an "assistant in the field" since 1875.

The fullness and value of Dr. Abbott's work in science can best be realized by glancing at the essays and reports which he has published.

Omitting purely literary productions, these cover one hundred and seventeen titles.

In the "American Naturalist," commencing with Vol. IV, 1870, to Vol. XIX, inclusive thereof, will be found contributions by him under forty-nine titles, covering 228 pages.

Twenty-two of these papers are leading articles; the others are "notes." They are all either archæological or zoölogical. The former, twenty-five in number, include the first communications by him, on the occurrence of palæolithic man in the valley of the Delaware River; and the article, on "The Stone Age in New Jersey," which was the basis from which his more elaborate works to be hereafter mentioned were developed.

Twenty-seven articles or notes in the "Naturalist" are zoölogical, and twenty-five of them treat of birds or fishes of New Jersey; of the other two, one is on the "Habits of Cray-fish," and the other is on "Winged Ants."

The most important zoölogical paper of this series is that on "Traces of a Voice in Fishes." In this article, Dr. Abbott aims to show that a relationship between color and voice obtains among our fresh-water fishes; that brightly colored fishes are diurnal in habits and attract the *eye* of the opposite sex, in the breeding-season; but dull-colored fishes are nocturnal, and the sexes are attracted by the *ear*. Studies in the tropics of marine fishes tend to confirm this view.

He has contributed to the English journal, "Science Gossip," beginning in 1872, first under the editorship of M. C. Cooke, and afterward of Dr. John E. Taylor, twenty articles, of which eighteen were illustrated.

In "Science," Vols. I to VI, both inclusive, are seventeen communications, eight of which are leading articles. Those on the "Intelligence of Fishes," and supposed "Æstivation of Mammals," have attracted much attention. In the articles on "Hibernation," Abbott aims to show that, in so fluctuating or uncertain a climate as in New Jersey, hibernation is not so fixed a habit as has been supposed, and is "optional" with many mammals; they hibernating when cut off from food-supplies, and so avoiding starvation. Intelligence appears to play a prominent part in this series of articles, for, besides the "Intelligence of Fishes," already mentioned, we find among them papers on the "Intelligence of the Crow"; of "Birds"; of "Batrachians"; and of "Snakes"; and one on "Color-Sense in Fishes." The archæological articles relate the occurrence of amber near Trenton, New Jersey, and of mound-builders' pipes in New Jersey; and concern "Palæolithic Man in Ohio," "Evidences of Glacial Man," and "Eastern and Western Indian Implements."

To "Nature" he contributed, in 1872, "American Flint Arrow-Heads," "Origin of American Indians," and "Feeding Habits of the

Belted Kingfisher"; in 1875, "American Stone Implements," "Habits of the Kingfisher," "Occurrence of Flint Scalping-Knives in New Jersey," "Supposed Marriage Emblem of American Indian Origin," "Iron Axes from West Virginia," and "Stone Masks from New Jersey"; in 1876, "American Stone Tubes and Tobacco-Pipes," and "American Flint Skin-scrapers"; and, in 1883, a note on the origin of the American dipper's power of diving and aquatic habits, being a reply to the Duke of Argyll's objections to an evolutionary view of the origin.

Of eight contributions to "Science News," which was published by Ernest Ingersoll and W. C. Wyckoff, in 1878 and 1879, one entitled "Do Opossums play 'Possum?" is noticeable because it is an endeavor to show that the animal when attacked or captured is overcome by fear, and does not designedly simulate death; and develops the view which was subsequently published by Romanes as entertained by Darwin in his posthumous essay on "Instinct," which was printed by Romanes, in his "Mental Evolution in Animals." Abbott's independent conclusion as expressed in this paper was published four years prior to the appearance of Romanes's book or of Darwin's essay.

In "The Popular Science Monthly" he has published papers on "Certain Phases of Bird-Life," "Birds' Nests," the "American Chipmunk," "To what Extent is Evolution visible?" "An Inscribed Indian Tablet," "Migration of Inland Birds," "Traces of a pre-Indian People," "The Nest and Eggs of the Thistle-Bird," "Some Rambles of a Naturalist," "Archæological Frauds," and "Animal Weather-Lore." Among his contributions to other volumes are the "Report on Fishes of the Delaware River," and "Winter Habits of Fishes of the Delaware River," in the United States Fish Commissioner's Report for 1875–'76; "Catalogue of Vertebrate Animals of New Jersey," in the State Geological Report for 1868; "Palæolithic Man in America," in Kingsley's "Standard Natural History"; "The Stone Age in New Jersey," in the Smithsonian Annual Report for 1875; papers on Chipped Stone Implements, Stone Mortars and Pestles, Cooking Vessels, Wood Implements, Pipes, Sculptures, Bone Weapons, etc., in Wheeler's "Report upon United States Geographical Surveys west of the One Hundredth Meridian"; on "The Discovery of Supposed Palæolithic Implements from the Glacial Drift in the Valley of the Delaware River," near Trenton, New Jersey, in the "Reports of the Peabody Museum of American Archæology and Ethnology," for 1876 and 1878; "An Historic Account of Discoveries of Palæolithic Implements in the Trenton Gravels," in the "Proceedings" of the Boston Society of Natural History for 1881, and of the "Discovery of Human Remains in the same Gravel," in the "Proceedings" for 1883.

Also, from time to time he contributed to young people's magazines, such as the "Riverside" and "St. Nicholas," and more recently to weekly papers of the higher class, articles of popular zoölogical character. In 1883, Dr. Brinton, of Philadelphia, read a paper on "Palæolithic Implements," by Dr. Abbott, at the meeting of the Congress des Americanistes, in Copenhagen.

In 1881, Dr. Abbott published his first volume, "Primitive Industry, or Illustrations of the Handiwork in Stone, Bone, and Clay, of the Native Races of the Northern Atlantic Seaboard of America." Pp. 560. Illustrations 426. George A. Bates, Salem, Massachusetts.

The work may be said to be the natural outcome of the fact that the author lives in a neighborhood once densely populated by the Indians; but its appearance was also expedited, if not occasioned, by the encouragement which he received from the Peabody Museum, at Cambridge, in prosecuting an exhaustive search for traces of man in the valley of the Delaware.

The collection of stone implements made by Dr. Abbott in New Jersey was placed, years ago, in the Peabody Museum at Cambridge, and has since been added to yearly, until now fully twenty thousand specimens are on exhibition. It has recently been said of it in "Science," that it "is one of the most important series of the kind ever brought together, and one which archæologists will consult for all time to come."

The volume is composed really of three parts; and the aim of the author is to show that, during the close of the Glacial Epoch, if not earlier, man, associated with arctic mammals, occupied the valley of the river; this being indicated by the occurrence *in* the gravels of stone implements alike in character with the palæolithic implements of Europe, but made of dense argillite, instead of flint; later, as attested by a class of better finished objects made of argillite, and as a class found under circumstances indicating antiquity greater than the ordinary surface-found Indian relic; lastly, the ordinary jasper and quartz arrow-heads and sandstone axes of the Indians proper.

Since the publication of the book, a vast deal of material has been gathered, and the result has been to confirm the views expressed in the volume. A fragment of a human cranium, a lower jaw, a tooth, and lately a fragment of a human temporal bone, have been taken from the implement-bearing gravels. A critical reviewer, in the "Nation," has said of the volume: "It is a valuable addition to the sum of our knowledge of aboriginal man; . . . as such, it is abundantly worthy of a place beside Mr. Evan's elaborate treatise on the 'Ancient Stone Implements of Great Britain.'"

In 1884 was published "A Naturalist's Rambles about Home" by D. Appleton & Co., New York. It is a selection, in part, from many contributions to zoölogical journals, but also contains much original matter. It is exclusively "field" studies, and results of daily observations of the animal life about the author's home.

In February, 1886, Harper & Brothers, of New York, published "Upland and Meadow," a volume on the same general style as the preceding, but in no instance repeating the subject-matter of the earlier volume. The two books give a nearly complete account of the fauna of a New Jersey farm; an account which will be really completed by the publication of a third volume, treating largely of botanical features.

An idea of the quality of Dr. Abbott's books—the true flavor can be enjoyed in its perfection only in reading the books themselves—is given in the London "Academy's" (May 1, 1886) notice of "Upland and Meadow," which concludes:

"Books like this make us more interested in America than do the countless volumes of travelers. There is that charm of freshness, that power of interesting us, as much as the writer was himself interested, that frank inquisitiveness—though it may smack a little of the modern interviewer, carried to the world of upland, meadow, river, and trees, taking stealthy views at the midnight side of Nature with a dark-lantern—which make the book attractive from beginning to end, which make us read every page, and make it, by our keeping it as a book of reference, memorable. It abounds not only in facts, but in fancy; and so a boy from school or a world-wise father will find that it adds to his joys in the open air, or reveals the wonderful life about his feet."

Dr. Abbott is a corresponding member of the Boston Society of Natural History; of the New York Academy of Sciences; of the Linnæan Society of New York; of the Nuttall Ornithological Club of Cambridge, Massachusetts; of the Anthropological Society of Washington, D. C.; of the Numismatic and Antiquarian Society of Philadelphia; and of the Davenport Academy of Sciences, Davenport, Iowa; and is a Fellow of the Royal Society of Antiquaries of the North, Copenhagen.

CORRESPONDENCE.

"THE JOINT-SNAKE IDIOCY."

Messrs. Editors:

IN "The Popular Science Monthly" for December, 1886, Dr. Felix L. Oswald, in discussing "Zoölogical Superstitions," speaks incidentally of the "joint-snake." He says:

"The joint-snake idiocy, on the other hand, though knocked to pieces a hundred times, persists in reviving with symbolic promptitude. In the Rocky Mountains, on the lower Mississippi, and all through the southern Alleghanies, farmers and hunters still believe in the self-reconstructive power of a reptile that survives dismemberment, with the facility of a New York tramway ring, and, after picking up a jaw-bone here and a couple of vertebræ there, pursues its way rejoicing, and ready to segregate again at a minute's notice."

This sneer is the "last straw" which prompts me to relate, for the first time in public, what I know of the joint-snake. I have seen three specimens, all in their native haunts, and all in the meadows of a farm on which I lived but two years of my life. Hence I know that it was within that period that I saw all three of them. It was during the last years of the war.

I saw them at different times and in different places, but no two of the places, I should say, were more than fifty rods apart. I could very nearly locate all three of the places now. I distinctly remember the direction each snake was going, the direction it was from me, the order in which I saw them, and what occurred at each observation. I shall briefly relate the circumstances of each case, and the observations made.

The first was in haying-time. In gathering up a forkful of hay to "top out" a wagon-load, which was just ready to start for the barn, I discovered a snake of a kind I had never before seen. It was not a large snake. I should say it was about the size of the average garter-snake—say, twenty inches long. It was also shaped very like a garter-snake. Its head was noticeably small, and inclined to be square built. It was the most innocent-looking serpent I had ever seen. It was longitudinally striped, of a dull-white and a pretty and decided gray.

It did not "fly to pieces" when I touched it. I did not strike it hard. The first hint I had that I had caught the far-famed joint-snake was when I saw it lying before me in several joints—I should say five, six, or seven. I then made no further effort to kill it. I bent over it, in the broad daylight of high noon, and carefully examined its parts, in spite of the repeated urgent appeals of my brother to hurry off to the barn with the load of hay, as it was nearly dinner-time.

The joints were quite regular in length, and three or four inches long, the head and tail joints being somewhat the shorter. Each joint had at its front end five fleshy processes, shaped very like a necked strawberry, and apparently fitting into five holes in the rear end of the next anterior joint. The processes were pointed in front, and reached their greatest thickness about a good tenth or an eighth of an inch from their attachment to the joint. I distinctly saw and counted the processes, and also the holes into which I supposed they had fitted. It was a neat piece of dove-tailing.

I put one of the pieces into my pocket, to carry home and save as a curiosity. Then it occurred to me that after all the main point was to see whether the joints would come together again and that the loss of one of its joints might defeat it. So I laid my selected joint down again with the rest, and, carefully marking the spot, went to dinner. That over, I returned to the field and to the marked spot; but no snake of any kind was there.

The second time was in another field, also at haying-time, probably a year later. This time I recognized an old acquaintance, and cut him in two about the middle with my scythe. This was also at noon on a bright day, and before going to dinner I laid down my scythe so as to mark the spot. And again, when I returned, there was no snake. I saw him divide into pieces, and saw that I had cut one of the joints in two about the middle. As in the first case, the joints were regular in length and shape, and the connections were the same. The proportion of length of joint to length of snake was also the same. I touched the snake in only one place. I let him crawl across my scythe-blade until his middle was on the edge, and then I set my shoe-sole on him and the sharp edge neatly and quickly cut him in two. Then he went to pieces all the way along, and I left him lying untouched.

The third time was in another field adjoining that one, and at a different time of the year, on a cloudy day. This time I was older, and quite interested. I could easily have killed him, had he been any kind of a serpent of his size. But this time I was at leisure, and determined to give my old friend a very thorough examination. So I looked about for a stick long enough to lay gently upon him without danger of being bitten. Meantime he looked about for a hole in the ground, which he was fortunate enough to find before I found a suitable stick. I saw him glide into the vertical hole, and I have seldom parted with a friend more sadly. I still hope some day to go back to that farm and find and keep a real joint-snake. I have never seen one elsewhere.

Ever since that day I have sought in books a fair description of my friend, but in vain. He is called a "glass snake," his breaking to pieces is ill-described, his coming together denied, and he is made the butt of ridicule, as in the above extract. In his behalf I can only testify that he goes to pieces, of regular lengths, by an easy motion, the cleavage occurring at points where he is not touched, and the joints having an admirable arrangement for reconstruction. I always supposed it was a defensive provision, a "'possuming" process, to deceive the enemy into the belief that his victim was dead, when in fact he was not. Before I had seen one, I used to reason with my school-fellows as to the possibility of joints in the intestines. I now see that the first joint would suffice for the intestines. The cutting off and reopening of channels for the circulation of the blood offer no difficulty.

I never based any positive conclusion on the disappearance of the two specimens which I saw dismembered. I always considered the easy possibility of their having been devoured by large birds. There were no domestic animals in either case to disturb them.

The puzzling question to me is, what possible object has Nature or Divinity in jointing that snake, if his going to pieces, which I know to be at least semi-voluntary, is the end of him? Pending an answer, I shall believe him capable of reconstruction. I was never in the slightest degree superstitious in such matters, and was always skeptical about the joint-snake until I saw it and examined it. I have been very careful not to relate anything more than I actually saw. I was between thirteen and sixteen years old at all these times. I am under the impression that I was fourteen years old when I saw the first specimen.

The farm was in Des Moines County, Iowa, about eight miles west of Burlington, and lay across the Chicago, Burlington and Quincy Railroad.

Henry J. Philpott.

Des Moines, Iowa, *December* 1, 1886.

EDITOR'S TABLE.

PROPHETS OF EVIL.

IT is remarkable how many able writers are devoting themselves now-a-days to proving that, under the influence of the scientific and philosophical theories most in vogue, modern society is rushing to destruction. It is also remarkable that, in spite of the clearness with which they discern the danger, not one of them comes forward with a single practical suggestion as to how it may be averted. Last year we had a novel from the pen of a leading French Academician, M. Octave Feuillet, the special object of which was to show how particularly destructive the doctrines of Darwin were to female virtue. The leading character, a certain freethinking and free-living viscount, marries an extremely estimable and rigidly orthodox lady, to whom at the time he is sincerely attached, but whose marked aversion to fashionable follies becomes in the course of time a weariness to him. He then falls in with a young lady who had been brought up by a scientific uncle in complete emancipation from all theological dogmas. This young woman, perceiving that the viscount has conceived a foolish passion for her, and would probably marry her were there no obstacle in the way, seizes a favorable opportunity of poisoning his wife. The plan succeeds perfectly, and the viscount finds himself now with a wife who is prepared to plunge with him into all excesses of gayety and frivolity. He finds, too, that he is not himself more completely emancipated from all severe notions of domestic virtue than is the lady to whom he has given his name and his title. In a word, the pace at which this interesting creature wants to go is as much too fast for him as the pace at which he was going a few years earlier was too fast for his first wife, the gentle "Aliette." The latter had left him one child, a daughter; and retiring to the country for a few days to visit this child, he learns from an old servant, then on her death-bed, the whole story of the poisoning of his first wife by the woman whom he had made his second. He learned, also, that the thing had been so managed as to make him appear, in the eyes of the dying Aliette, an accomplice in the horrible crime. Conscience-stricken and overwhelmed with remorse, he rushes to Paris and succeeds in banishing the murderess from society and from the country. He himself shortly after dies broken-hearted, but not before he has abandoned his worldly philosophy and embraced the religion of "Aliette"—Roman Catholicism. Such is the narrative as constructed from the inner consciousness of M. Octave Feuillet. The moral is obvious—that the Roman Catholic faith is the only bulwark against immorality and the disintegration of society. Substantially the same lesson is that which Mr. Mallock has been trying to teach, and which Mr. W. S. Lilly enforces in his recent "Fortnightly Review" article on "Materialism and Morality."

Now, it strikes us that all this momentarily fashionable writing is conceived in a very idle strain. What the world wants is not a succession of jeremiads over the effects likely to be produced by the prevalence of certain opinions, but a demonstration of the truth in regard to those opinions. If the theories of Darwin are false, let their falsity be exhibited. If Mr. Spencer's wider scheme of evolution is illusive, let its illusiveness be proved. The press is as free for the opponents of these great thinkers as for their adherents. The platform is open to them; the pulpit as yet is theirs almost exclusively. They can have nothing, therefore, to complain of as to the conditions of the controversy; and yet in all their utterances we may detect a certain note of dissatisfaction, as if, somehow or other, the verdict were unjustly going against them. The verdict, however, will follow the evidence; and the world will not accept as evidence against a scientific theory the mere assertion that its moral effects are injurious. That assertion itself would have to be proved far otherwise than through the easily constructed mechanism of a novel with its puppet figures moving hither and thither at the will of the manipulator. To the earnest mind of the old Roman poet Lucretius the free, untrammeled study of Nature was the chief preservative against evil thoughts and practices; and how easy it would be for a skillful writer, adopting this hypothesis, to write a novel in which all the conditions and consequences of M. Feuillet's narrative would be reversed! No, there is no argument in this kind of thing. Evolution, as a system of thought, has not gained ground by the aid of the novelist, and it is not going to succumb to a novelist's attacks. It has gained ground because it has explained many things previously inexplicable and has shed light into every department of Nature and of thought. It can not, therefore, be dispossessed of the ground it has gained till a stronger than it appears, some view or theory that will explain more things than it can explain, and shed more light upon the problems of existence than it can shed. The whole question lies here in a nutshell. The thinking world is not fatally or irrevocably bound to the formulæ of Darwin and Spencer; it adheres to them only for the service they render, and is prepared to lay them aside so soon as any superior generalizations are brought forward.

Supposing, however, that we admit that the moral results of the introduction of the new philosophy are not satisfactory; supposing it to be true that men, in their new-found liberty from certain external sanctions, are showing a great want of self-control and an indifference to all moral aims—what are we to conclude? Simply this, that the moral education of the race so far has been lamentably defective, that it has not sufficed to bring the lower impulses under subjection to the higher, that it has not taught the love of virtue for its own sake, that it has left men enslaved to purely personal hopes and fears and without any conception of the larger life in society—a life regulated by justice and sweetened by good-will—which is really attainable in greater or less degree by every normally constituted human individual. The evolution philosophy is, in a certain sense, a *régime* of freedom; and if a certain society, at a certain date, is found to be unfitted for it, we conclude, not that the *régime* of freedom is bad in itself, but that the society is backward and undeveloped. It is no condemnation of parliamentary institutions to say that they are not suited to Caffres or Malays. If it should be said that the doctrine of evolution is as much unsuited even to the most advanced societies of to-day as parliamentary institutions are to Caffres or Malays, we might reply, "The more's the pity, seeing the doctrine has come into the world, and has apparently come to stay." We should prefer, however, to traverse the assertion, and to say that the ready acceptance which is being given to the doctrine is primary evidence of its being suited to the needs of at least a large section of the community. Some may take it and abuse it, as they would any other doctrine, converting it, as certain sectaries a couple of centuries ago did the Christian doctrine of justification by faith, into a scheme of antinomianism. But this does not do away with the fact that the doctrine has an intellectual attraction for nearly all the more advanced minds, and that these therefore may reasonably be supposed to have some power of adapting themselves to it. In all periods of transition allowance must be made for the disorders incident to the unsettlement of men's minds. At the period of the Reformation these disorders were of the most alarming kind—far more alarming than anything we have to contemplate at the present moment. The duty of the hour, therefore, for those who accept the new ideas, is to face whatever may be the difficulties of the situation boldly, and to apply themselves to developing and demonstrating all the useful truths that are deducible from the theory of evolution. The time has come to throw upon men in a distinct and emphatic manner the full responsibility for their own actions. Heretofore the teaching has been that unless men held to certain special doctrines and theories, they could not be expected to live pure or righteous lives; and under this teaching much moral weakness has been engendered. To-day it is in order to proclaim to one and all that they must settle their opinions with themselves; but that, whatever they may *think*, there is only one line of *conduct* that befits a man born into a civilized society, and that is a conduct marked by self-restraint, and a care for the good of the whole social organism. The prophets of evil are doing evil, and that continually. They are helping on that relaxation of morality which they deplore, seeing that they deny all moral authority to principles not founded on their own special dogmas. There is great need of an organized effort to antagonize the mischievous effect of their writings by preaching hope where they preach despair, and the progress of humanity through increasing knowledge where they announce the dissolution of all social bonds through the advent of a philosophy which has the misfortune of not being theirs.

A STRANGE SIGHT IN SOUTH AFRICA.

Everybody nearly has been reading that wonderful tale of imaginary adventures, "King Solomon's Mines"; but perhaps not very many have noted the most startling and extraordinary fact recorded in it, one in comparison with which all the other marvels recorded are the merest commonplace. The gifted narrator tells us how, shortly after the sun had sunk in the west, there came a glow in the east, and presently "the crescent moon peeps above the plain and shoots its gleaming arrows far and wide." What do our astronomers say to this—the crescent moon rising in the east shortly after sunset? It won't do, Mr. H. Rider Haggard! We will believe your elephant stories, if you like, follow you into ghostly caves, and accept with a reasonable discount what else you tell us that is remarkable; but we don't believe that in South Africa, or anywhere else on this planet, the crescent moon rises in the east shortly after sunset. It can't be done as the solar system is arranged, and you should have left that out. Speaking seriously, it does seem extraordinary that a man who all his life has seen the crescent moon setting in the west shortly after the sun, should, even for a moment, imagine that he could see it rising in the east at the same time of day. Tom Hood has described a somewhat similar case for us in his "Love and Lunacy," where "Ellen" drives her astronomer-lover distracted by announcing that the moon is at the full, and that she is thinking of him; the fact being that the moon had been full just three weeks before, and that the object she took for the full moon was "the new illuminated clock." Of poor "Ellen" Hood tells us that—

> "As often happens when girls leave their college,
> She had done nothing but grow out of knowledge."

But here we have the same thing over again fifty years later, and on the part of a really clever writer; the only difference being, that whereas "Ellen" saw the full moon (or said she did) at a date when it was not to be seen, Mr. Haggard affirms that he saw the "crescent moon" rising about the hour when, if visible at all, it must really have been setting. Popular education has been advancing during these fifty years; but it is still, we fear, the exception for people to be taught to interest themselves in even the more important phenomena of the physical world. If it could once be realized to how large an extent the intelligence of the community must depend upon the assimilation of true scientific knowledge, and how increasingly important it is becoming from year to year that the public mind should be fortified by intelligence against ill-digested and revolutionary theories, we believe a new impetus would be given to scientific instruction everywhere. We do not wish to make too much of the careless blunder into which the author of "Solomon's Mines" has fallen; but, seeing that such blunders are possible in such a quarter, teachers might well take some special pains to draw attention to the facts in this simple matter. Here, we may say in conclusion, a book like Miss Bowen's "Astronomy by Observation" is an excellent guide. As its title partly indicates, it summons the student to a close personal observation of the movements of the heavenly bodies, and thus brings the facts home to him more vividly than could be done by any amount of purely theoretical dissertation.

LITERARY NOTICES.

History of the Pacific States of North America. By Hubert Howe Bancroft. Vol. XXIV. Oregon, Vol. I. San Francisco: The History Company. Pp. 789.

The more remote events in Oregon affairs have already been given in the "History of the Northwest Coast." The later volumes, to which this one belongs, deal with events that occurred within the memory of men now living. They have been wrought out from original sources, and contain a large proportion of facts which have never before appeared in print. The author has found it more difficult to treat fully and fairly this comparatively modern epoch, from crude material, than earlier ones which had been worked over by scholars. Of hundreds of personal narratives used in making the history, no two wholly agree; "and yet, to the careful student, with all the evidence before him, the truth is generally clear." The leading features of the history of Oregon, Mr. Bancroft points out, are not the pursuit of conquest, but commercial enterprise and agricultural industry, "the Fur Company, the missionaries of different sects soon converted into rival traders, and the middle class from the United States, all contributing of their several characteristics to form a society at once individual and independent. It is in the missionary, rather than in the commercial or agricultural elements, that I find that romance which underlies all human endeavor before it becomes of interest sufficient for permanent preservation in the memory of mankind. A mountain-walled plain, between the coast elevations and the northern stretch of the great Andean range, with a fertile soil, a genial climate, and picturesque scenery, through a peculiar sequence of events, becomes the Western Utopia of the American States, and kindles in the breasts of those who here lay the foundations of a commonwealth the fire of patriotism, forever sacred even when fed by fallacies. The silent conquest of this area by men and women from the border, intent on empire, is a turning-point in the destinies of the country; and it is to me no less a pleasure than a duty to recognize the heroic in this conquest, and to present one more example of the behavior of the Anglo-Saxon race under the influence of American institutions." We find these remarks to a considerable extent verified as we turn over the chapters devoted to the history of the missions, which are replete with personal adventure, and varied with incidents that might serve as the framework of many romances. Mr. Bancroft is disposed to take an optimistic view, which is nearly peculiar to the frontier, of the fate of the Indians, of which he says that, "aside from the somewhat antiquated sentiments of eternal justice and the rights of men as apart from man's power to enforce his rights, the quick extermination of the aborigines may be regarded as a blessing both to the red race and to the white. . . . And this happy consummation—the swift and sharpest means of sweeping from the earth every human incumbrance—the people of the United States have never been backward about. . . . Avarice, injustice, and inhumanity are often the most important aids to civilization. In this respect, with noble intentions and devout aspirations far higher than ordinary, the settlers of Oregon but followed their destiny. They labored for the best, and quarreled not with the inevitable." The story in the present volume begins with the application of the Flathead Indians to Mr. Clarke, Indian agent at St. Louis, in 1832, for religious men to be sent "to point their people the way to heaven," and is continued till the erection of a territorial government in 1848.

A Treatise on the Practice of Medicine. By Roberts Bartholow. Sixth edition, revised and enlarged. New York: D. Appleton & Co. Pp. 990. Price, $5.

The first edition of this book appeared in 1880, as a companion volume to the author's already published work on "Materia Medica and Therapeutics." The edition of three thousand copies was exhausted in less than a month, anticipating the judgments of the numerous medical journals of the country, and a new edition was called for, in which the text was revised and two articles of importance were added. Evidence of continued giving of satisfaction to the needs of many readers appeared in the steady, rapid sale of the work, and a third edition appeared in 1882, again revised, and with fifty pages added. A fifth edition followed close upon a fourth, in the spring of 1883, and in it the *bacillus tuberculosis* was noticed, and the increase of minute organisms in pathogenic importance was recognized. The book itself, in the beginning, was undertaken while the author was Professor of the Theory and Practice of Medicine and of Clinical Medicine in the Medical College of Ohio, on the urgency of students and practitioners who attended his lectures, and of many readers of his therapeutical treatise. The author was more inclined to the work, because the subject was one to which he had devoted all the years of his professional life, and under the most varied conditions, of army service before and during the rebellion, and an extensive practice of sixteen years at Cincinnati. With one or two exceptions, he has had personal charge of the maladies treated of in the work, and has made them the subject of clinical demonstration or *post-mortem* investigation. In preparing the present edition, he has sought to make it still more worthy the approbation of his readers as the most certain method by increasing its practical resources. While not overlooking the advances made in scientific medicine, he has devoted most attention to the clinical aspects of the subject; but with the effort to preserve due harmony and proportion. Some new subjects have been introduced, and preliminary chapters have been appended to the chief divisions of the work, to make the study of the diseases of the class more exact, and to enhance the practical character of the whole; and the author hopes that little properly pertaining to the domain of practice has been overlooked, and nothing superfluous has been added.

Studies in Ancient History, comprising a Reprint of "Primitive Marriage." By the late John Ferguson McLennan. A new edition. London and New York: Macmillan & Co. Pp. 387. Price, $4.

The "Primitive Marriage," or "Inquiry into the Origin of the Form of Capture in Marriage Ceremonies," although confessedly only a tentative investigation, or, as the author phrased it, "an exercise in scientific history," made its mark at once when it first appeared, and has held a foremost place among works of original research for twenty years. Although republished twice within that period, it has been given both times unaltered: the first time because the author had been prevented from superseding it by the more comprehensive work he had intended, while, in the presence of the earnest demand for it, with or without revision, it was considered "better that it should be made accessible to students with its imperfections, than that it should remain inaccessible to them"; and the second time, in the present edition, as a posthumous work, for which the same demand was still current. It is, however, followed up with a second volume containing other writings of the author, "from which it will be possible to gather, in a considerable measure at least, how far the author's views had grown or been developed, how far they had changed or been added to, subsequently to the appearance of "Primitive Marriage." A few notes are given, which are confined to certain matters on which the author had announced a change of view, and to some other matters, such as Mr. Lewis H. Morgan's speculations, where circumstances had made an additional statement imperative. In an appendix to "Primitive Marriage" is given a pretty full collection of examples of the form of capture, upon the basis of a collection which the author published in 1866. The examples thus brought together suffice, at least, to show an extraordinary diffusion for this custom.

Entertainments in Chemistry: Easy Lessons and Directions for safe Experiments. By Harry W. Tyler. Chicago: The Interstate Publishing Company. 16mo. Pp. 79. Price, 60 cents.

This is another volume in the "Educational Series" published by the Interstate Publishing Company, and referred to elsewhere in these columns. The author gives a number of experiments that can be readily performed with very simple apparatus and a few cheap chemicals. His choice of subjects covers a wide range: thus, for instance, in one chapter he relates the history of a candle, in another he tells about the chemistry of yeast, in a third he treats of combustion and explosion, and in a fourth of soap. The book is well and entertainingly written, and the experiments for the main part well chosen. It seems to us, however, that in a book of this kind the experiments with hydrogen might have been better omitted, because it is questionable whether, even in the hands of a more experienced worker, such experiments can be regarded as "safe" ones.

N. W. Ayer and Son's American Newspaper Annual, 1886. Pp. 1010. Price, $3.

This publication, now well known, contains full information about the newspapers published in the United States and Canada, the places where they are published, the business enterprises of those places, and their political proclivities, arranged and classified by States and counties in such a way as to be of the most benefit to advertisers, all of which is revised from year to year. The information on which the annual revision is based is collected in

March of each year, and is subject to correction till the first of July, while later information is admitted in the form of advertisements up to the hour of going to press. The publishers believe that the present—the seventh—is an improvement upon any preceding volume; and the information has been more carefully gathered, and is even more trustworthy, than heretofore. There have recently been added to the headings descriptive of States and counties sections showing, from the census of 1880, the number of manufacturing establishments of all kinds at that time, with the amount of capital invested in them, the number of hands employed, and the value of their annual products, while the State headings show, in addition to the summaries of these facts, the amounts paid in wages, and the value of the raw materials used.

The Theory and Practice of Surveying. By J. B. Johnson, C. E. New York: John Wiley & Sons. Pp. 683, with Maps and 150 Text Illustrations. Price, $3.50.

The large field which the word surveying necessarily covers, renders every attempt at bringing all the different materials together in one volume a rather difficult and perplexing task. Theory and practice are, in hardly any other branch of human activity, so closely connected with each other as they are in the execution of surveyor's work, in which the most exact methods and appliances have to be used in order to secure the degree of accuracy which is always desirable, whether the surveying be done for scientific and national purposes or for the protection of private interests.

The volume under review is designed for the use of surveyors and engineers generally, for whom it will be a valuable reference-book; but it is intended especially for the use of students in engineering, who will find it a complete guide in their studies, containing all that should be familiar to them when they enter practical life as engineers or surveyors.

The text is divided into fifteen chapters, with some appendices and tables. All the apparatus described are, when necessary, shown in illustrations. The instruments used by surveyors are described in the first part, the first six chapters being devoted to instruments for measuring distances, instruments for determining directions, instruments for determining horizontal lines, instruments for measuring angles, the plane-table, and additional instruments used in surveying and plotting.

The second part is devoted to the methods which find application in surveying, the separate chapters being devoted to land surveying, topographical surveying by transit and stadia, railroad surveying, hydrographic surveying, mining surveying, city surveying, the measurement of volumes, geodetic surveying, projection of maps, map-lettering, and topographical symbols. The chapters devoted to railroad, hydrographic, mining, and city surveying—the two latter of which the author acknowledges have been contributed respectively by C. A. Russell, C. E., U. S. Deputy Mineral Surveyor of Boulder, Colorado, and William Bouton, C. E., City Surveyor of St. Louis, Missouri—are of special interest even to practiced surveyors, as they treat of special branches of surveying, about which little, if any, mention is ever made in books for the use of students.

What may be called the scientific part of surveying—geodetic surveying—is fully treated and made comprehensible to those whose purpose is not to devote themselves to geodetical work exclusively, but who have, all the same, to be familiar with the scopes and purposes of geodetical measurements, as every engineer and surveyor has to be.

Of the appendices, one is on the judicial functions of surveyors, by Justice Cooley, of the Michigan Supreme Court; the second is a copy of instructions to United States Deputy Mineral Surveyors for the District of Colorado (1886), while two others contain derivations and formulas. A number of tables for easy reference and for practical use are added at the end.

Three plates accompany the text. One is an isogonic chart of the United States, containing all the data accessible up to 1885, reduced from the United States Coast Survey Chart; Plate II contains all the conventional signs for topographical maps; and Plate III is a topographical practice survey executed by the sophomore class in the Polytechnic School of Washington University. The author is Professor of Civil En gineering in Washington University, St. Louis, Missouri. As a whole, this "Theory and Practice of Surveying" will be found a very acceptable addition to the literature on the subject. It will be of great value to the student, who will find through it, and in a readable form, access to information which was formerly only attainable in separate books by different authors.

The Town and City Government of New Haven. By Charles H. Levermore. Baltimore: N. Murray. Pp. 103. Price, 50 cents.

This is one of the "Johns Hopkins University Studies in Historical and Political Science." The incorporation of New Haven city was achieved in the face of no little opposition, and was wrought out through friction between several strongly defined elements in society. The process is nearly the same as that which all towns have to go through in the course of their development, and Professor Levermore's tracing of it through its several steps may be regarded as an illustration from an example typical in many respects, and as a study in a normal course of municipal evolution. The first aspect presented is that of the jealousy between "town-born" and "interlopers"; then the commercial spirit is introduced through the activity of the interlopers. The first phases of city politics are sketched in the distinctions of Patriot and Tory marking the division-lines at elections. The first municipal charter was obtained in 1784, and after that came question after question to be debated, voted upon, and decided. The charter of 1869 marked a culminating point in the constitutional development of the municipality. Previous to that time it had been a more or less thriving, overgrown village. The gradual growth of municipal power exhibited in succession many slowly shifting phases, but a typical, fundamental conservatism could be discerned. Through their nearly two hundred and fifty years of life, the town and region of New Haven have preserved a local character—a well-defined individuality, separate from those of other old colonial centers. Political affiliations have strengthened rather than diminished its exclusiveness. The rivalry between New Haven and Hartford means much more than commercial competition between two urban populations. It is the contention of regions rather than of cities. It is traceable through the whole history of the State back to the charter quarrel of 1662–'64, when one colony was pitted against the other. The dependence of the former New Haven Colony upon New York, which geographical location necessitated, was encouraged by successive animosities; and, "if a line be drawn diagonally across the State from the northwest corner to the mouth of the Connecticut River, the towns and cities to the west of that line are found to rest upon New York as an economic and social basis, just as those upon the east side derive their inspiration from Boston. Of the former of these tracts, New Haven is the capital; of the latter, Hartford. This division of influences should be borne in mind when we read that, in the Revolution, New Haven and Fairfield Counties contained many Tories, while the eastern part of the State was almost unanimously patriotic; that a Windham County mob forced the New Haven stamp-distributor to resign in 1765; and that, one hundred years later, it was, as usual, the Hartford end of the State—the eastern counties—which held the State firmly for Nation with a big "N," and neutralized, by steady and large majorities, the conservative, oligarchical, and pseudo-democratic tendencies of Southwestern Connecticut."

House-Plants as Sanitary Agents: Or, the Relation of Growing Vegetation to Health and Disease. By J. M. Anders, M. D. Philadelphia: J. B. Lippincott Company.

Dr. Anders makes an apology for adding to the number of books, on the ground that he is working in "a branch of scientific literature which, in the form of a book, has not hitherto found an exponent." The apology is not necessary; the book fully justifies its appearance. The purpose of the volume is to set forth, in plain terms, the latest light regarding the effects of some of the various physiological functions in plants and flowers upon the atmosphere in general, and the air of dwellings in particular, as well as the application of this knowledge to the laws of health. Most of the conclusions put forward have been arrived at from the results of an almost continuous series of personal experiments extending over a period of eight years. These conclusions are —to sum them up into one—that plants and flowers, particularly when cultivated indoors, are worthy to be placed in the foremost rank of sanitary agencies. Further, "the mass of evidence at hand relating to the subject, in the author's opinion, establishes the complete efficacy of living plants as preventive measures in that deadly malady, consumption of the lungs, as well as the signal services they are capable of rendering in certain other conditions of disease." We do not understand the author as recommending in-door life among flowers at the expense of out-door life—if he did, we should differ with him decidedly—but as holding flowers up as a valuable sanitary element of in-door life, and as a substitute, so far as they may be a substitute, for out-door life to those who are not able to enjoy it. A chapter is added on the practical cultivation of plants in the house; and the last chapter is devoted to the consideration of the "Sanitary Influences of Forest Growth." We have to thank Dr. Anders that he has not made his book by dumping into it the magazine articles he has written on the subject, as it is too much the fashion to make books now, but that he has written it all out afresh, in harmonious arrangement, and has thereby given us a compact, symmetrical treatise.

Geological Survey of Alabama. By Eugene A. Smith, State Geologist. Bulletin No. 1. Tuscaloosa. Pp. 85, with Nine Plates.

The "Bulletin" comprises two monographs, the first being a preliminary report on the tertiary fossils of Alabama and Mississippi, by Truman H. Aldrich, and the other "Contributions to the Eocene Paleontology of Alabama and Mississippi," by Otto Meyer. Mr. Aldrich's paper is the first installment of a work which is designed to be a complete account of the paleontology of the tertiary formation in Alabama. In preparing it, the author has personally gone over the greater part of the ground, and has collected a large part of the material himself, so that he has been able to give to each species both its locality and its exact place on the stratigraphical scale. The work is, therefore, not a bare description of species, but it illustrates very fully the distribution of the species both in time and space. To it Dr. Smith adds a summary of the lithological and stratigraphical features and subdivisions of the various deposits which make up the tertiary formation in Alabama. In Dr. Meyer's paper a number of new or previously unfigured species of invertebrates are described and figured, and a very few known species are refigured for some special reasons. The type specimens of the fossils are in the author's collection.

Report of the United States National Museum, under the Direction of the Smithsonian Institution, for the Year 1884. Washington: Government Printing-Office. Pp. 458.

This report constitutes Part II of the Report of the Board of Regents of the Smithsonian Institution. A clear account is given in the report of the assistant director of the organization, administration, and arrangement of the museum collections. In the account of the function and aims of the museum, reference is made to the attitude occupied by some special investigators who are disposed to neglect the claims of the educated public to the enjoyment and instruction which museums afford, and demand that those institutions be administered for the benefit solely of persons engaged in research, as the manifestation of a spirit which defeats its own purpose. "The experience of Europe with its magnificent educational museums, and the history of the several expositions in the United States, should be quite sufficient to satisfy any one who has studied the matter that the museum is an educational power even more influential than the public library." The show of specimens in the cases was, in the year covered by the report—and presumably still is —but a feeble index to the richness of the collections, for "the development of the exhibition series is necessarily slow, since it is not considered desirable to place on exhibition specimens which are not fully explained by printed labels. . . . The extent and nature of the work of the museum are not appreciated by persons who are not familiar with the character of the laboratory-work, and who have not access to the reserve stores. In the various departments of ethnology and industrial art, for instance, the wealth of the museum is exceedingly great, but, until cases have been built and labels printed, it is impossible properly to display it." But the museum is expected, as this work advances, to improve rapidly in attractiveness to the visitor and general student, and in convenience to the investigator and special student. Besides the general report and review of the year's work in the scientific departments by the assistant director, the special reports of the curators and acting curators of the twenty sections and departments are given: a bibliography of the museum, a list of accessions for the year, and special papers, having much interest, on "Throwing Sticks" and "Basket Work of the North American Aborigines," by Professor Otis T. Mason; "Eskimo Bows," by John Murdock; "A Spotted Dolphin" and "The Florida Muskrat," by Frederick W. True; and "The West Indian Seal," by Frederick W. True and F. A. Lucas.

Analysis of the Urine, with Special Reference to the Diseases of the Genito-Urinary Organs. By Professors Hofmann and Ultzmann. Translated by T. B. Brune, M. D., and H. H. Curtis, M. D. Second edition. New York: D. Appleton & Co. Pp. 310. Price, $2.

The favor with which this work has been received in medical circles is attested by the fact that it appeared in three languages during the year of its publication. The present issue is the second edition of the English translation, and contains some additions by the pen of the translators. While the book does not pretend to be an exhaustive treatise on the diseases of the genito-urinary organs, it brings all that is essential for the student and the practitioner. Some of the subjects treated of in the different chapters into which the text is divided, are: the histology of the uninary organs, the urine, reagents and apparatus for the approximative determination of the urine constituents, general diagnosis, diagnosis of the diseases of the urinary apparatus.

Great attention and care are of course paid to the different chemical methods of testing and analyzing the urine and its constituents, and the directions are so clearly given that by attentive study and observance of these the student can speedily become proficient in the execution of analyses and in the interpretation of the results obtained.

Eight colored plates, finely finished, are added to this volume. These are not given in the German edition, but are taken from another work, by the same author, on the "Sediments of the Urine." These drawings are to serve as aids in the microscopic examination of the urine deposits, for the microscope bears a part fully as important as chemical analysis in investigations of this kind.

Oils and Varnishes. Edited by James Cameron, F. I. C. Philadelphia: P. Blakiston, Son & Co. Pp. 376. Price, $2.50.

This book, one in a series of technological hand-books, contains essentially the matter given in Cooley's "Cyclopædia" and supplemented from the latest publications. It is intended for all interested in and working with varnishes and oils, and contains a great deal of practical information. After an introductory chapter on the chemistry of oils, the animal, vegetable, and mineral oils are successively considered at length and in detail. Under the head of "Testing Oils" the different physical and chemical tests are given that can be advantageously employed; the latter tests embrace methods for both qualitative and quantitative determinations. Separate chapters are allotted to "Resins and Varnishes," and "Testing Resins." The appendix furnishes some interesting tables of prices in England of oils, tallows, essential oils, resins, and varnishes, and statistics of the quantities and values of oils there imported for some years past.

Through a Microscope. By Samuel Wells, Mary Treat, and Frederick Le Roy Sargent. Chicago and Boston: The Interstate Publishing Company. 16mo. Pp. 126. Price, 60 cents.

This little hand-book is one of a series which is designed to make young readers acquainted with and interested in the elements of natural science. The enlistment of three authors for the preparation of so small a volume seems quite formidable, but each takes up a special part of the subject and treats of that.

Mr. Wells discusses the simple outfit needed by beginners in the fascinating study of microscopy, gives suggestions as to proper objects to be studied and their preparation, and tells of some simple experiments that will entertain the young student at home in the winter-time, when snow and storms forbid the seeking of subjects for his study in field and meadow.

Mary Treat tells of some interesting plants and animals whose life-history she has observed and studied under her microscope; and Mr. Sargent's contribution is on "A Home-made Microscope, and how to use it," an article which will be sure to please boys of an inventive turn of mind. Quite a number of illustrations are given, which add considerably to the interest and value of this little treatise.

Van Nostrand's Science Series. 18mo. 50 cents each. The Luminiferous Æther. By De Volson Wood, C. E., M. A. Pp. 121.

Hand-Book of Mineralogy. Determination, Description, and Classification of Minerals found in the United States. By J. C. Foye, A. M., Ph. D. Pp. 180.

Flow of Water in Open Channels, Pipes, Sewers, Conduits, etc. By P. J. Flynn, C. E. Pp. 118.

Treatise on the Theory of the Construction of Helicoidal Oblique Arches. By John L. Culley, C. E. Pp. 125.

Few properties of the luminiferous æther appear to have been accurately determined, except that of transmiting light at the rate of 186,300 miles per second, and the ability to convey a definite amount of heat energy from the sun to the earth.

Proceeding from these data, the author of the first book on our list seeks, by a long train of reasoning and considerable figuring, to determine and establish what certain other properties this æther must possess. He comes to the conclusion that its density must be such "that a volume of it, equal to about twenty volumes of the earth, would weigh one pound," that the tension is such "that the pressure on a square mile would be about one pound," and that the specific heat is such "that it would require as much heat to raise the temperature of one pound one degree Fahrenheit as it would to raise about 2,300,000,000 tons of water the same amount.

In the "Addenda" are given extracts from Newton's "Principia," and from the works of Clerk-Maxwell bearing on kindred themes.

The "Hand-Book of Mineralogy" is intended by the author as an aid in determining the minerals found in the United States. It gives briefly the prominent and distinguishing characteristics of the different minerals, and aims at presenting the classifications usually adopted in arranging cabinets.

After a few introductory remarks on the apparatus and reagents needed, and a short chapter on blow-pipe reaction, follows the part devoted to the determination of species. This comprises two tables, the first for the "preliminary examination," the other for the "final examination," by means of which tables the nature of a specimen may be readily and rapidly determined.

The remaining part of the work is given to a description of the species, to the chemical classification, and to a classification by basic elements and ores.

A copious system of cross-references is supplied.

The "Flow of Water in Open Channels" is a book of formulæ and tables designed to save time and work for hydraulic engineers who make use of the formulæ of D'Arcy, Kutter, and Bazin, in preference to the older formulæ. As the former, however, although more accurate, are also as a rule more complicated and more troublesome in their application, a book of this kind, practically a ready method of applying the new formulæ, will probably render the use of them more general and popular.

Two objects are intended to be accomplished by the treatise on the construction of helicoidal oblique arches. In the first place, a clear and concise treatment of the construction is aimed at; and in the second place it is attempted to make plain and simple all problems connected with the theory or construction. The author believes that a thorough understanding of the process of the generation of helicoidal surfaces will remove all difficulties that usually present themselves to would-be students of this subject, and he therefore devotes the first chapter to a careful consideration of elementary principles. Appended is a brief discussion of logarithmic and ribbed oblique arches. Numerous cuts illustrate the principles explained.

The Making of Pictures. Twelve Short Talks with Young People. By Sarah W. Whitman. Chicago: The Interstate Publishing Company. Pp. 131. Price, 60 cents.

In this book the writer has undertaken to treat of the principles underlying the various processes of making pictures—oil and water-color painting, etching, wood and line engraving, photography, and the various reproductive processes.

First, the author, herself an artist, seeks to help her young friends to an understanding of what art is, and assist them to recognize that subtile "something" which marks the difference between a mere picture—no matter how well done—and a true work of art.

In this connection she speaks of the great laws that exist in art as well as in morals — which laws must be thoroughly understood and comprehended even by those who would merely *look* at pictures, and speak intelligently of them. Then she tells of the fundamental principles that underlie the different ways of making pictures. No attempt is made to teach how to paint in oil, or how to execute an etching, but the implements necessary are enumerated, and the modes of procedure in each process are sketched in clear, bold outlines.

Lectures and Essays by the late William Kingdon Clifford, F. R. S. Edited by Leslie Stephen and Frederick Pollock. With an Introduction by F. Pollock. Second edition. London and New York: Macmillan & Co. Pp. 443. Price, $2.50.

Professor Clifford was a thinker and philosopher — he can hardly be called a writer except in a subsidiary sense—of the rarest qualities of mind, and some of them unique. He seemed to have the power, to a degree which is seldom exhibited, of grasping comprehensively the most abstruse subjects, seeing into them clearly and deeply, and of expressing himself lucidly and vigorously upon them. No better conception can be gained of the character of the work which he produced, including the pieces which are embodied in this volume, than by taking a few views of the representations of the various sides of his nature as they are given by his friend Mr. Pollock, in the biographical introduction. The picture, as a whole, is a charming study of a man who differed much—in excellences—from others of his kind. Clifford began to attract attention not long after he had entered Trinity College, Cambridge, as a young man of extraordinary mathematical powers, and eccentric in appearance, habits, and opinions, and withal an ardent High Churchman. Mr. Pollock, his fellow-student, was early struck with the "daring versatility of his talk. Even then there was no subject on which he was not ready with something in point, generally of an unexpected kind; and his unsurpassed power of mathematical expression was already longing to find exercise." Being asked for aid in solving some elaborate geometrical theorem, he spoke, appearing "not to be working out a question, but simply telling what he saw. Without any diagram or symbolic aid, he described the geometrical conditions on which the solution depended, and they seemed to stand out visibly in space. There were no longer consequences to be deduced, but real and evident facts, which only required to be seen." This incident illustrates Clifford's theory of what teaching ought to be, and his constant way of carrying it out. He showed great taste for gymnastics, in which his accomplishments "were the only ones in which he ever manifested pride," and when he took his degree he had the distinction of being pointed out in "Bell's Life" as an example of a superior scholar who was also a superior athlete. While pre-eminently mathematical, he was at various times and in various ways marked out for honorable mention in classics, modern history, and English literature. He was fond of historical reading, but took a poetical or dramatical rather than a scientific view of the subject, and saw events "in a series of vivid pictures, which had the force of present realities, as each came in turn before the mind's eye." He did not care much, apparently, for the use of language as a fine art, although he had a great appreciation of arrangement and composition; and much of his best work was spoken before it was actually written. He had and exercised an aptitude for acquiring languages, and this probably turned, as Mr. Pollock suggests, on the fact that "a new language is a riddle before it is conquered, a power in the hand afterward; to Clifford every riddle was a challenge, and every chance of new power a divine opportunity to be seized." He prosecuted his studies in college with a view to what he wanted to learn rather than to passing the examinations, and therefore came out second wrangler, when by following the other course he might have been far in advance as first. This pursuit of knowledge for its own sake was the leading characteristic of his work throughout his life. "The discovery of truth was for him an end in itself, and the proclamation of it, or of whatever seemed to lead to it, a duty of primary and paramount obligation. This had something to do with the fascination of his teaching: he never seemed to be imposing dogmas on his hearers, but to be leading them into the enjoyment of a common possession. His affections went out to those whose lines of thought were in sympathy with his, without caring whether they agreed in results or not. Everything he said and did was straightforward; "and this, being joined to subtilty and wide range of vision, became in speculation and discussion a very formidable power. If there was anything for which he had no toleration, it was insincerity in thought, word, or deed. He expressed his own opinions plainly and strongly because he held it the duty of every man so to do; he could not discuss great subjects in a half-hearted fashion under a system of mutual conventions. As for considerations of policy or expediency that seemed to interfere in any way with the downright speaking of truth for truth's sake, he was simply incapable of entertaining them." Hence, and by reason of his charming social qualities, while it was possible to take offense at certain passages in his writings, it was "impossible not to like the man." Such was the man whose peculiar modes of thought are reflected in the essays in this volume. The papers, which are preceded by a few selections from Clifford's letters, are sixteen in number. The subjects are: "Some of the Conditions of Mental Development"; "Theories of the Physical Forces"; "The Aims and Instruments of Scientific Thought"; "Atoms"; "The First and the Last Catastrophe"; "The Unseen Universe"; "The Philosophy of the Pure Sciences"; "Body and Mind"; "The Nature of Things-in-Themselves"; "The Scientific Basis of Morals"; "Right and Wrong: the Scientific Ground of their Distinction"; "The Ethics of Belief"; "The Ethics of Religion"; "The Influence upon Morality of a Decline in Religious Belief"; "Cosmic Emotion"; and "Virchow on the Teaching of Science." The essays on "Types of Compound Statement," and "Instruments used in Measurement," which appeared in the first edition of the book, are omitted from the present one, having found a more fitting place in the volume of "Mathematical Papers," which was published in 1882.

Theory of Magnetic Measurements, with an Appendix on the Method of Least Squares. By Francis E. Nipher, A. M. New York: D. Van Nostrand. 1886. Pp. 94.

This hand-book was prepared to supplement the instructions of the Coast and Geodetic Survey; it furnishes information regarding the practical details of a magnetic survey. The discussion on the method of least squares is, as the writer states in the preface, an extension of an article in Weisbach's "Mechanics."

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Eccles, Robert G., M. D. Drugs and Digestion. Pp. 26.

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Sanborn, John Wentworth. The Roots and Stems of Words in the Latin Language explained and illustrated with Examples. Albion, N. Y. Pp. 14.

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Lloyd, James Hendrie, Philadelphia. Moral Insanity. Pp. 17.

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POPULAR MISCELLANY.

Methods of Arrow-Release.—Professor E. S. Morse, while shooting the bow and arrow with a Japanese friend, was surprised to find that the Japanese practice in handling the weapon was totally unlike ours. He then began collecting data illustrating the various methods of releasing the arrow from the bow as practiced by different races; and in time became convinced that the subject had importance, and the pursuit of it might lead to interesting results in tracing the affinities of past races. He has traced out five or six forms of release, which he classifies as the primary release—with the thumb straight and the forefinger bent, as children practice the world over; secondary release, in which the ends of the second and third fingers are also brought to bear on the string to assist in drawing; tertiary release, in which the forefinger, nearly straightened, is also brought to bear by its tip; Mediterranean release, the oldest historical method and the one prevailing in Europe, in which the arrow is lightly held between the first and second fingers, with the thumb straight and inactive, while the string is drawn back with the tips of the first, second, and third fingers; the Mongolian release, in which the arrow is held at the junction of the thumb and forefinger, the base of the finger pressing it against the bow, and the thumb is protected by a ring; the "irregular release" of the Temiangs of Sumatra; and the "archaic release" of the ancient Greeks. All of these releases have been practiced from the earliest historic times; and each of them, except the primary release, which admits of no variation, has one or more varieties. The two strongest and perhaps equally powerful methods are the Mediterranean and Mongolian; "and it is interesting to note the fact that the two great divisions of the human family who can claim a history, and who have been all dominant in the affairs of mankind, are the Mediterranean races and the Mongolians. For three or four thousand years, at least, each stock has had its peculiar arrow-release, and this has persisted though all the mutations of time to the present day." Prof. Morse remarks, upon the importance of a more systematic study of the methods of archery and the paraphernalia of the archers than has yet been done, that "the remarkable persistence of certain forms of arrow-release among various nations leads me to believe that, in identifying the affinities of past races, the method of using the bow may form another point in establishing or disproving relationships. By knowing with more certainty the character and limitation of the forms of arrow-release, another clew may be got as to the date and nature of fragments of sculpture representing the hand. The peculiar attitude of the archer might lead to the interpretation of armless statues."

Workingmen's Co-operation Organizations.—Mr. A. H. Dyke Acland, M. P., made some statements in the British Association concerning the operation of workingmen's co-operative organizations. After describing the plans on which the organizations are formed, he said that the result of their operation has been a gradual saving of capital, till there is often more than can be employed in the business; indeed, the difficulty with many societies is too much capital, not too little. The increase in the business of the societies between 1865 and 1885 was from about £3,000,000 per annum to more than £20,000,000 per annum. At the present time productive or manufacturing business of £3,000,000 or £4,000,000 a year, on a large or small scale, is carried on, the capital of which comes mainly from the distributive or retail societies. The two wholesale societies are the property of the retail stores, which have created them for their own convenience for the supply of articles direct to their shops from England and abroad. The English wholesale society like the retail societies has had to refuse capital which its members (that is, the retail stores) would willingly have deposited with it. It has adhered mainly to the work of the merchant, and has done comparatively little in the way of manufacturing. Some of the large stores have erected corn-mills and batteries, and many societies employ tailors, dress-makers, and the like, and some are now begining to rent farms. In the large stores there is a great demand for milk, butter, and agricultural produce. These facts throw light on the questions of the possibility of the accumulation of large sums of capital by workingmen; of the successful utilization of such capital by workingmen in industrial enterprise; and of the improvement of the position of the worker or the lessening of the assumed antagonism of employer and employed in consequence of such successful utilization of capital. In the discussion on Mr. Acland's paper, Mr. Evans, representing the Co-operative Congress Board, said it was remarkable to how great an extent the progress of co-operation coincided with the decline of the influence of socialistic teaching.

The Preservation of Water-Colors.—In a paper "On the Fading of Water-Colors," read in the British Association, Professor W. N. Hartley pointed out that colors consist of mineral substances, for the most part of a stable character, or of organic substances comprising stable colors and unstable and changeable colors. Excepting ultramarine, bodies of the former class may be considered unalterable unless they contain lead or mercury; those of the second class may be considered alterable under certain conditions. The action of light on these two classes of substances, when it is capable of affecting them, is different. On mineral substances the red rays cause oxidation; the oxidizing power decreases as the rays extend more toward the yellow; becomes null in the yellowish-green; is reversed and becomes a reducing power in the blue, and this is intensified in the violet and ultra-violet. On organic substances the action of light is an oxidizing one throughout, continuously increasing in power (except in the green, where it is diminished) through the red and yellow into the violet. The action is not confined to oxidation, for bodies of complex and unstable character may be changed in composition, and, being resolved into more stable compounds, changed in color or rendered colorless. In order to preserve water-color drawings in which delicate yellow and red tints are largely used, they should be kept in a very subdued light, preferably of a yellow tint, such as is yielded by daylight passing through blinds of unbleached linen. The action of the violet rays is from two to three times as powerful as that of the red and yellow, and the difference between the action of diffused daylight sufficient to view pictures and of direct sunlight is at least forty times as great, and in summer probably four hundred times. Hence a picture which would fade in ten years in sunlight might be preserved for something like twelve hundred years in a yellow light. The acidity of drawing-paper should be corrected by a wash of a dilute solution of borax; and in no case ought any paste, gum, or glue, to be placed at the back of a drawing for the purpose of mounting it.

The Mineral Springs of Europe.—Dr. J. Burney Yeo has made a classification of the mineral springs of Europe into groups according to the composition of their waters. The first group includes the simple thermal waters, or "indifferent" springs, the temperature of which is above 80° Fahr. The waters are chiefly used in baths, and, when administered internally, it is simply for getting the purifying solvent influence that might be obtained from drinking pure hot water. They are efficacious in chronic rheumatism, chronic gouty inflammation of the joints, sciatica and other forms of neuralgia; hysterical and hyperæsthetic states of the nervous system; old, painful wounds and cicatrices, and cases of loss of muscular power when not dependent on diseases of the nervous centers. Some of the most popular springs fall under the head of "common salt waters." Their strength varies, and it is customary to fortify them or dilute them, artificially, according as they may need. Used in baths, they stimulate the peripheral vessels and nerves, and promote capillary circulation. They improve the tone and nutrition of the skin, and indirectly stimulate tissue-change. Internally they act as stimulants and indirectly as tonics to the organs of digestion and assimilation; but in persons with highly sensitive mucous membranes they may cause irritation and discomfort, especially if given in too large doses. They are employed in baths in cases of hypersensitiveness of the skin; in some forms of retarded convalescence from acute disease; in scrofulous and inflammatory enlargement of joints; and in chronic hypertrophies of certain organs. Internally they are beneficial in cases of atonic dyspepsia and chronic gastric catarrh, and in those low states of health which are often contracted by prolonged residence in tropical climates. The alkaline waters are characterized by the presence of considerable proportions of carbonate of soda and free carbonic acid in varying amounts, and are exemplified at Vichy. Some of them also contain common salt, when they are classed as muriated alkaline waters, and some, of both simple and muriated springs, are hot and some cold. Many of the springs of this class are found to be most valuable curative agents. The waters are all taken internally, and are used in baths, but not very largely. They are applicable to the treatment of a great number of chronic maladies. In moderate doses they are solvent and purifying, correct acidity, promote tissue-change, and possess active diuretic properties. If taken too largely, they depress the heart's action and cause emaciation. They are given in cases of acid dyspepsia; in gouty constitutions; in cases of renal calculous disorders and gravel; in diabetes; and in cases of torpid liver, with tendency to gall-stones, in constitutions which would not bear the stronger aperient waters. They are of service in the treatment of chronic catarrh of the bronchial and other mucous membranes. The waters containing common salt are more tonic and stimulating than the simple alkaline waters. The group of the sulphated waters includes all the best-known aperient waters, which owe their peculiar qualities to the presence of soda and magnesia, singly or combined. Some of the springs contain also carbonate of soda and chloride of sodium, which add greatly to their remedial value. This has led to the subdivision of the group into the simple sulphated or bitter waters—Friedrichshall, Pullna, and Hunyadi—and alkaline sulphated waters—exemplified in Carlsbad, Marienbad, Franzensbad, and Tarasp. The iron or chalybeate waters are the tonic waters. They are valuable in proportion to their purity—that is, to the absence of other solid ingredients—and in proportion, usually, to the amount of free carbonic acid that they contain. A sixth group comprises the numerous and well-known sulphur-springs, both hot and cold, which are freely used for baths. The celebrated Pyrenean spas are nearly all hot sulphur-springs, and the most famous of them all are those at Luchon, the hottest of which has a temperature of 154°, and requires cooling before it can be used. The seventh and last group consists of the earthy and calcareous waters, which are marked by a preponderance of the earthy salts of lime and magnesia. In baths, their action is much like that of the simple thermal waters. At Contrexéville, they are administered internally for dyspepsia, and in calculous and vesical complaints; but the precise mode of their action is not well understood. Probably much of their efficacy is due to the large quantity of an active solvent, such as hot water, which the patient is induced to consume; and this, Dr. Yeo hints more than once, may be a chief element in the virtue of all the springs.

Land-Waves.—Professor W. Mattieu Williams maintains that the tidal waves, rushes of the sea, and other phenomena of the kind observable in connection with earthquakes, are not affections of the sea, but of the land. It is the land that undergoes the upheaval and depression that are remarked, but which, as observed by land-dwellers and made known to them by changes in the relative level of land and sea, are attributed to the latter. The great Krakatoa wave "swept half-way round the earth without being felt by any vessel out at sea. It was felt badly enough on land, and on land only. The great wave that made such havoc at the earthquake of Lisbon was evidently a land-wave. It was the rising and falling of the land, not of the sea, that buried the solid marble quay of Lisbon. As Lyell says, 'The quay sank down with all the people on it, and not one of the dead bodies ever floated to the surface.' In its place the water is now one hundred fathoms deep." An account is given in "Nature" of June 3, 1886, of a phenomenon witnessed at Stonehaven, where, at intervals, just before and after high tide, without any apparent cause, the water along the coast rose and fell from ten to eighteen inches at a time, the subsidence leaving as much as from fifteen to eighteen feet of the beach dry. The disturbance continued for three hours, during which "there was no wind, and the sea was quite smooth, but the water advanced and retired with a speed equal to the run of a large river during a spate." It was surmised that the phenomenon was due to some eruption or subsidence in the sea-bottom; but, to Professor Williams, "it appears far more probable that an undulation of the coast itself was the cause, the rising of the land causing the recession of the sea, and *vice versa*. A sea-wave, however caused, on advancing over a shallow, sloping bottom with a fall of from ten to eighteen inches in from fifteen to eighteen feet, would break and form a 'roller,' and distinctly show itself as a 'ground-swell.'" Many other mysterious rushings of the sea on the coast may be similarly explained. They demand more careful study than they have received.

The Rocky Mountains.—Describing the British Columbian Rocky Mountains, before the British Association, George M. Dawson remarked that the term "Rocky Mountains" is frequently applied in a loose way to the whole mountainous belt which borders the west side of the North American Continent. The mountainous belt is, however, preferably called the Cordillera region, and includes a great number of mountain systems or ranges, which on the fortieth parallel have a breadth of not less than seven hundred miles. Nearly coincident with the forty-ninth parallel, however, a change in the general character of the Cordillera region occurs. It becomes comparatively strict and narrow, and runs to the fifty-sixth parallel, or beyond, with an average width of about four hundred miles only. This portion of the western mountain-region comprises the greater part of the province of British Columbia. It consists of four main ranges, or systems of mountains, each including a number of component ranges. These mountains are, from east to west, the Rocky Mountains proper, mountains which may be classed together as the gold ranges, the system of the Coast Ranges of British Columbia (sometimes improperly named the Cascade Range), and a mountain system, the unsubmerged portions of which constitute Vancouver and the Queen Charlotte Islands. The system of the Rocky Mountains proper, between the forty-ninth and fifty-third parallels, has an average width of about sixty miles, which, in the vicinity of the Peace River, on the fifty-sixth parallel, decreases to about forty miles. It is bounded on the east by the Great Plains, which break into a series of foot-hills along its bases, and on the west by a remarkably straight and definite valley occupied by the Columbia, Kootenay, and other rivers. Since the early part of the century the trade of the fur companies has traversed this range, chiefly by the Athabasca and Peace River Passes; but, till the explorations effected by the expedition under Captain Palliser in 1858-'59, nothing was known in detail of the structure of the range. During the progress of the railway explorations a number of passes were examined, and in 1883 and 1884 that part of the range between the forty-ninth parallel and latitude 51° 30′ was explored and mapped in some detail in connection with the work of the Canadian Geological Survey by the author and his assistants. Access to this, the southern portion of the Rocky Mountains within Canadian territory, being now readily obtained by the railway, its mineral and other resources are receiving attention, while the magnificent Alpine scenery that it affords is beginning to attract the notice of tourists and other travelers.

Dr. Le Plongeon's Researches in Yucatan.—Mrs. Alice D. Le Plongeon, who, with Dr. Le Plongeon, has been zealously engaged in exploring the ancient ruins of Yucatan, read a paper at one of the meetings of the New York Academy of Sciences, in 1886, on some of the results of their joint observations. It related principally to the cities of Uxmal and Chichen-Itza. The "Governor's House" at Uxmal is three hundred and eighteen feet long, and is divided into twenty rooms, the two largest of which are sixty feet long, with ceilings in the form of triangular arches. Outside, the cornice above the doorways supports a magnificent entablature, with designs which, according to the author's interpretation, represent the face of the mastodon, and embody facts concerning the foundation of the city, with statues of the founders. North of this building is a palace of one hundred and two rooms, the arching entrance to the court of which bears traces of paint, and various red hands. "Similar imprints are seen in several buildings, because it was customary for those who used or owned the edifice to dip their hands in red liquid and press the palm against the wall to invoke a divine blessing for the house and inmates, and also to denote ownership." All the façades of this building are elaborately ornamented, and each is different from the others. The prevalent ornament is that of the feathered serpent in different attitudes and designs. On one side, at each end of the façade, was a serpent's head, the tail of the other one drooping over it. They had seven rattles, and just above them was an urn-ornament, with a long plume dependent from it. The heads were crowned, and in the distended jaws of the one yet in place there is a bat's head, and in the bat's mouth the face of a woman. A distinction is made between these serpents and the Maya serpent-emblem of the spirit of the universe, which had not rattles, but a dart at the end of the tail, and not feathers, but wings, and here and there something like fins. In what is called a grand castle at Chichen-Itza are many sculptured pillars, and among the figures represented several men with faces in profile, having long beards. One of them was so like Dr. Le Plongeon that the Indians said it was himself who had lived in that place in ages long gone by! It seems that they believe in reincarnation. In another building is a series of mural paintings representing religious ceremonies, domestic scenes, and battles, the figures of which are said to "show a far more skillful hand than those portrayed in the paintings found in the tombs of Egypt." Near here was found what was regarded as a mausoleum, elaborately ornamented with sculptured macaws and leopards and a leopard-sphinx, in the interior of which, at twenty feet below the surface, were discovered a large statue and two urns containing the cremated remains of the prince, to whom the whole was a monument, with articles in jade, chalcedony, and greenstone. The statue was drawn out, but was afterward seized by the Mexicans and taken to the museum at the capital. In another mausoleum, besides the funerary urn, with the manes and talismans and the statue, were found one hundred and eighty-two conoidal pillars, some painted blue and others red, and twelve serpent-heads, "exquisitely sculptured and painted in bright colors." The decorations on the outside of the building are chiefly representations of the face of the mastodon, and between the eyes of twelve of those faces is a human face surrounded by an aureole, or halo, of life-size. Dr. Le Plongeon claims to have discovered the key to the Maya hieroglyphics, and assumes to interpret all these figures, carvings, and inscriptions, to which he gives definite historical significance. We are not aware that the validity of his theory and interpretations has been critically passed upon.

A "Nearly Perfect" Civil-Service System.—Mr. Gordon Gray has attempted, in the "Fortnightly Review," to estimate the value of the competitive examinations which prevail in the British official service, as it is shown by their workings. His general conclusion is that "we have no sufficient evidence as to the working of open competition in the Home Civil Service, but that in the Indian Civil Service and the army we have a balance of testimony, official and independent, to the effect that the officers selected under it have shown themselves not unworthy of their positions. But as much as this could surely be said for their predecessors. There is no evidence that the new men are superior to the old, no positive evidence even that they are altogether their equals, for their opportunities have been fewer; and it yet remains to be seen whether when the opportunities do come the men will rise to the occasion." Earl Salisbury said in 1874, writing to the Indian Government: "With respect to the principle of competition itself, the evidence you have collected sufficiently shows that it can not be disturbed without injury to the public service. The expressions of opinion which I have received from competent judges in England lead me to the same conclusion. Of its success as a mode of selecting persons fit to serve in the Indian Civil Service there seems to be no reasonable doubt. The ability which it collects is not the same in kind as that which distinguished the servants appointed under the previous system, and there may be truth in the allegation for which some of your officers contend, that under it instances of conspicuous ability are rare. . . . On the other hand, it is generally admitted that if exceptional powers are rarer than in olden times, exceptions of an opposite kind have almost entirely disappeared." Since this was said, wholesome improvements have been introduced into the examinations. Mr. Gray sees defects in the British system, and objects to it that it does not profess to discover the best men "all round," but "only professes to discover those who can pass the best literary examination in a limited number of subjects. Whether these men are inferior or superior to their competitors, in physical and moral qualifications, it neither knows nor inquires. It indeed inquires rigorously into those qualifications to the extent of discovering absolute unfitness, and occasionally a successful competitor at the literary examination is rejected for unfitness under one of these heads, but the test is only one of minimum qualifications. The authorities have only a right of excluding a candidate who fails to satisfy them that he just reaches the minimum; they have no power to give preference to conspicuous merit over mediocrity." Mr. Gray adds that a system of selection which should bring all the three elements—the mental, the moral, and the physical—that compose the human individual into competition, "would indeed be perfect." The civil-service examinations conducted under our Civil-Service Commission are intended to satisfy this requisition. They are not literary, but comprehensive and practical; and they are varied for each position to which they are applied, for the purpose of bringing out the evidence of fitness in the peculiar qualities which it demands; they are, therefore, wisely directed to approach what the author characterizes as a "nearly perfect" system.

Increase of Temperature in Lake Superior Mines.—H. A. Wheeler has made observations of the differences of temperature in the copper-mines of Keweenaw Point, Lake Superior, which, being now among the deepest mines in the United States, present an excellent opportunity for obtaining data as to the rate of thermal increase with descent into the earth. While the usual thermic gradient is from fifty to fifty-five feet for an increase of temperature of 1° Fahr., exceptional gradients, both higher and lower than this, have been obtained in some places. Measurements were computed in five mines having depths running from six hundred and seventeen feet to nineteen hundred and fifty feet, with distances between rating stations in each about one hundred feet less than the total depth of the mines. The results obtained show that the thermic gradient in this region—the average of the five mines giving ninety-nine feet to the degree—is one of the lowest that has ever been noted. A view to the cause of the low gradient is indicated by the variations between the different mines. Keweenaw Point is a tapering peninsula extending some seventy miles toward the middle of the lake. None of the mines are, consequently, very far from the water; and those nearest to the lake-shore have the lowest gradient, while those farther away have the higher or more rapid rate of increase. Considering the magnitude of Lake Superior, and the fact that only its surface waters change in temperature, while the great body of its deep waters remains at the temperature of maximum density, or about 39° Fahr., the lake appears to act "as a great cold blanket," giving the general coolness to the rocks which has been observed in the region, and preventing the rapid rise of temperature within the depths to which the mines have penetrated, which occurs under normal conditions.

The Mounds of the Canadian Northwest.—In a paper read before the British Association, Mr. F. N. Bell, of Winnipeg, described the sepulchral mounds of the Canadian Northwest. He pointed out that a continuous line of mounds may be traced from the mound-centers of the Mississippi River to Lake Winnipeg. Human remains, much decayed, were found in them, all buried by being placed on the surface under heaps of earth, in which patches of charcoal and ashes frequently occur. One mound had a burned-clay and bowlder floor, similar to the "sacrificial mounds and altars" of Ohio. Ornaments of sea-shells, which must have been fully twelve hundred miles from their native waters, had been found in these mounds. In addition, the author had discovered an ancient camp on the bank of Red River, near a group of mounds. The mounds from Lake Winnipeg down to the Gulf of Mexico were of the same character, and were probably made by one race. Though whites had found great diversity of mortuary customs prevailing among Indian tribes inhabiting that great tract of country, little exploration had yet been made in the Canadian Northwest, which offered a wide and productive field to archæologists. The mounds were very ancient, and were situated in what were the best game districts.

Some Parrot-Stories.—An English paper publishes a number of interesting and some amusing parrot-stories. One of them might help to illustrate the proverb, "When the cat's away, the mice will play." A young couple went away from home for some weeks, leaving the house in charge of the servants and a parrot. After their return, the parrot would repeat, from time to time, "Let's have another bottle—there's no one here to know!" accompanying its words with the sound of the appropriate "plop!" Another story is not unlike it. A Yorkshire gentleman had a fever, and his parrot was taken from the dining-room to the kitchen. During its abode there, of several weeks, it stole the raisins intended for a plum-pudding. The cook in anger threw some hot grease at it and scalded its head. When the master got better, the parrot's cage was taken upstairs again, and the bird, seeing the gentleman's newly shaven head, said, slowly, "You bald-headed ruffian, so you stole the cook's plums!" Some of the stories may throw light on the question whether or not the parrot adapts its remarks to the circumstances. There was a cockatoo that never asked for potatoes except when dinner was on the table, and never said, "Oh, you are a beauty!" except to a child. Dean Stanley, when Canon of Canterbury, had a parrot which, one morning at breakfast-time, got up into a tree and attracted the attention of all the servants, who gathered around it. The canon then came out, when the parrot looked down at him and said in a low but distinct voice, exactly like Stanley's, "Let us pray." It was evidently reminded of the assembling of the servants at morning prayers. A gray parrot was stationed in a nursery, where his greatest delight was to see the baby bathed. The child becoming sick, the parrot was sent to the kitchen. There, after a time, he set up a terrible cry, "The baby, the dear baby!" All the family rushed down, to find the parrot, in the wildest excitement, watching the roasting of a sucking-pig. A parrot, which was a slow learner, was taught till it could repeat verses, when, if it made a mistake, it would say angrily, "You are no good"; but, if it went on without error, it praised itself. There is considerable difference in the capability of parrots to learn, and in the way they learn. One is taught with difficulty, but remembers. Another picks up everything that is going on, and remembers nothing for more than a few days. Some few learn easily and also remember well. There are parrots which have a better ear for music than for words, and some which will whistle and sing, and not speak. Moreover, the best acclimatized parrot is easily upset by a change of food or attendance, but especially of surroundings.

NOTES.

A SPECIMEN of the *vibikari*, or sacred snake of Japan, in Dr. Stradling's collection at Watford, England, recently gave birth to between sixty and seventy young ones. Some fifty living and still-born snakelets were collected, and it was believed that at least a dozen more had been destroyed by other snakes in the cage. At ten days old the young ones had cast their skins, and were beginning to eat earth-worms and small slugs. These snakes well illustrate the curious provision of a temporary, long, chisel-like front tooth with which baby-snakes are enabled to cut their way through the soft, membranous envelope of the egg. They showed fight as soon as they were born, and were always ready to snap at an intrusive finger. This is the first time this species has bred in Europe.

SIR EMERSON TENNENT long ago called attention to the power of the cocoanut-palm to conduct lightning, and the subject is again called up by a Ceylon paper. Five hundred of these trees were struck on a single plantation during a succession of thunder-storms in April, 1869. But the trees suffer terribly from the effects, for, however slightly they may be touched, they are sure to die. Even if only the edges of the leaves are singed, or only a few of them are turned brown, the tree will in the end wither gradually and perish.

DR. J. STUART NAIRNE, of the Glasgow Samaritan Hospital for Women, has recorded several instances in his practice in which the use of fish, boiled or fried, as food, by patients, even when considerably advanced in convalescence, was followed by evil consequences; and he had begun to believe that, under any circumstances of debility, fish was a very dangerous diet, and forbade its use. Further observation taught him that the fault was not in the fish itself, but in the method of cooking it; and that when steamed, instead of being boiled or fried, it was much more easily digestible and perfectly harmless.

MR. J. STURGEON explained to the British Association a scheme for the introduction of compressed air-power into Birmingham. He showed that although each 1,000 horse-power at the central station may only produce 500 effective horse-power at the user's engines, it will displace fully 1,000 horse-power of small boiler-plants, furnaces, chimneys, etc., and the same engines can be used with compressed air as with steam. The centralization principle permits the use of engines and boilers of large power, with all the modern improvements. At the pressure proposed (forty-five pounds) the air-driven engines will indicate from thirty to sixty-five per cent of the power developed at the main engines, according to the mode of using the compressed air.

THE Rumford Medal of the Royal Society has been awarded to Professor Samuel P. Langley for his researches on the spectrum by means of the bolometer.

SUMMING up the points of an address on "What constitutes Malignancy in Cancer?" Dr. Herbert Snow, of the cancer Hospital, London, expresses the conclusion that the phenomena designated by that term "result from conditions which irritate normal protoplasm, cause it to proliferate abnormally, and to assume a quasi-independent parasitic vitality. These conditions may be mechanical; in a much larger proportion of cases they are neurotic. That is the farthest point we have yet reached; nor do I see how our knowledge of cancer can make much advance until we know far more than at present about the ultimate properties of protoplasm, and the manner in which this is influenced by states of the nervous system."

IT is reported that the state management of railways has proved a practical failure in all those countries where private lines have been allowed to compete with it. Instead of the government regulating the private railroads, as it was expected to do, it is regulated by them, and has had to adjust its terms to meet those which they imposed. In Belgium, the Government railroads, and the canals, also owned by the Government, have had something very like what we call a "railroad-war" with one another. The "mixed system" has been abandoned—in Belgium and Prussia, by state management having been made almost universal; and in Italy by its having been practically given up.

M. A. Bulle, of Besançon, France, has effected the direct electro-chemical deposition of palladium on iron, steel, and other metals. The deposition is made directly and of any required thickness, and constitutes the last process in finishing the manufactured article.

In a paper read before the British Association, Lord Rayleigh described the method of experiments which he had made for measuring the intensity of reflection from glass and other surfaces, and the results. With a piece of optically-worked blackened glass the amount reflected was .058 of the incident light. The amount of reflection depended greatly on the clearness and polish of the surface. In one case repolishing increased the amount from ·04095 to ·0445. Fresnel's formula gave in this case ·04514. Generally it appeared that the amount reflected was less than according to Fresnel's formula—a result contrary to Rood's. The numbers for polished glass, and for silver on glass, were ·94 and ·83.

The Uralian Society of Lovers of the Natural Sciences will open a Scientific and Industrial Exhibition of Siberia and the Ural Mountains, at Ekaterinburg, on the 27th of May, to continue till the 27th of September, 1887. The mining and metallurgical enterprises, for which the Ural is famous, will be fully represented; in the ethnographic department, the interesting aboriginal tribes of Siberia will be illustrated by groups of living families, with their habitations, furniture, implements, and costumes; and the archæological collections will be to a large extent composed of objects which have never before figured at an exhibition of the kind. Reduced fares from Nijni-Novgorod will be provided for by the committee, of which Mr. A. Mislawsky is chairman.

OBITUARY NOTES.

M. Dubsc, a distinguished optician of Paris, died in October. He is best known for having assisted M. Léon Foucault in all his constructions, and especially in the organization of his automatic electric lamp.

Professor Paul Morthier, for twenty-one years Professor of Botany at the Academy of Neufchâtel, Switzerland, has recently died. He studied medicine in his early days, and became a skillful surgeon; then he studied botany under Dr. Oswald Heer; was appointed to his professorship in 1862; was the founder of the Swiss Botanical Society; and was regarded as a high authority on sponges.

M. Chancourtois, General Inspector of Mines in France, who has recently died suddenly in Paris, was the author of several works on geology, and a professor in the School of Mines.

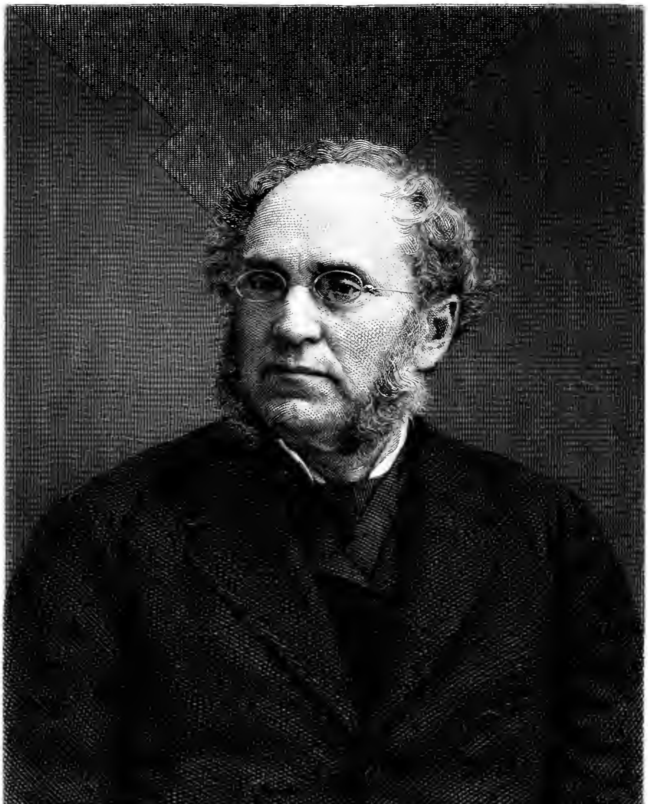
The death has been reported of Elie Wartmann, Professer of Physics in the Academy at Geneva. He was the author of numerous important researches and books, among which were those on Daltonism (1840), voltaic induction, the simultaneous transmission of dispatches in opposite directions on the same wire, and on electric currents in plants. He contributed largely to the organization and arrangement of the splendid physical cabinet of the University of Geneva.

Alexander Boutlerow, a Russian chemist, has recently died, at the age of fifty-eight years. He was a pupil of Wurtz's, and, as a professor at Kazan and afterward at St. Petersburg, was largely instrumental in introducing modern chemical theories into his country. He took part in the foundation of the University for Women at St. Petersburg in 1879. His most important researches were on fatty bodies and the isomerism of the hydrocarbons. His treatise on organic chemistry was translated into German. He was interested in apiculture, on which he wrote some popular manuals, and was a believer in spiritualism, on which he also wrote a book—"Psychical Studies."

M. Jules Bouis, an eminent French chemist, member of the Academy of Medicine and Professor in the School of Pharmacy, died on the 21st of October, aged eighty-four years. He studied chemistry in Dumas's laboratory; distinguished himself by numerous experiments; and was engaged during a large part of his life in teaching chemistry in various important schools in Paris.

General John Theophilus Beaulieu, F. R. S., who has recently died, at the age of eighty-one years, performed a long service in India, beginning in 1820. He was for some time Superintending Engineer in the Public Works Department for the Northwest Provinces; founded the system of magnetic observations in India; and was the author of a book of logarithms.

The death, at Berlin, is reported of Dr. A. Fischer, who resided for a long time at Zanzibar, and by whose energy much has been added to our knowledge of the Kilimanjaro region



Sincerely Yours
E. L. Youmans

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ARE RAILROADS PUBLIC ENEMIES?

By APPLETON MORGAN.

THE American Railroad, as an institution, is not immaculate. Its general offices are no more insured against entrance of designing and wickedly-minded men than is the pulpit, the Sunday-school, or the strawberry-festival. Granted, however, that, like most human concerns, the American railroad needs reformation, the very considerable question arises, Where shall we look for the reformer? It has not yet come, perhaps, to be a principle in economics that the safest and most expert administrator of a specialty is the one who has had the least practical experience thereof. But there nevertheless appears to be, if not an exact enunciation of such a principle, a by no means unusual tendency to such a practice. A great transatlantic steamship, *en route* from shore to shore, or a limited express train, with its costly freightage of packed Pullman, express, and baggage carriages, easily represents millions in money value, besides its human freightage. The captain, the conductor, the engineers, and crew are picked men, raised to their several responsibilities through every lower grade of drill and experience, adapted each to his part by long usuetude: who have been intrusted with all this precious burden by those who must answer with their fortunes, their liberty even, for the waste of its loss. Let the great steamship founder, the limited crash through a trestle—living or dead, these men will be found at their posts. But there will never fail of gifted gentlemen, eminent conversationalists, ready writers to the newspapers, who happened to be in their downy beds while these men were perishing, but who, nevertheless, will tell us exactly what this company and their picked employés should have done, and how the catastrophe might have been avoided. The design of this paper is to call attention to a recent capital instance of this tendency.

The problem of railway management and operation has grown so intricate; so vast, so complicated and enormous, that it is a maxim that no one man, whatever his habitude, knows "how to run a railroad." The executive officer, the auditor, superintendent or actuary of twenty-five years' service, instead of having kept abreast of his employment, finds that his service has outgrown him, not in fact alone, but in proportion; and that he can deal with remote details only when concreted by his subordinates into results which in turn are *his* details. He is himself only the pendulum of the clock-work, the governor of the engine; without his co-operatives and assistants he is powerless, although at the outset of his quarter-century he may have been equal to every item of his department.

Take a single trunk line connecting the city of New York with that Western focus to which, like Rome, all roads lead—Chicago. Every one of its army of eighty thousand employés knows his duty: his duty, often duplicated, perhaps, yet not duplicated, since every item of circumstance must daily and hourly vary it. From the president to the track-walker, no single individual could justify his employment for an instant, did he not, besides his routine, know precisely the single and only proper thing to do to save life and property in any contingency, foreseen or unforeseen; and, moreover, how in the performance not to swerve one atom below or above his exact prerogative. And if—in operation, the reciprocal duties of these eighty thousand must be exactly and incessantly performed in order that every passenger and every pound of freight shall reach its debarkation in safety—what single mind can grasp the relation of numberless such trunk-lines to the great public who trust their lives, persons, and property to them all? Add to this situation that this public, having largely invested their fortunes in these very transporting lines, are dependent for its incomes from their prosperity. Does not the great ramification strike us as one rather too enormous for any single recipe to meet, or to be guided by any one infallible and inexorable rule of constant and rigid procedure?

There is not a single criticism of railway management or outbreak of popular anti-railway feeling which has not its own perfectly well-known periodicity. As a rule, they lapse with time and disappear without exposition. But that all these criticisms and complaints should be carefully clipped, hoarded, pasted together, and sent out as a monograph signed by one name, is an occurrence so exceptional that its occasion might seem to warrant a replication to the array, once for all. Such an occasion seems the appearance of a handsome volume from an eminent press, which not only deals with the entire problem above suggested as a whole (the "Railways and the Republic," by James F. Hudson, New York, 1886), but impresses further as compiled by a gentleman who not only has never been engaged in the management of railways, operatively or financially, but has never discovered, in all the immense delicacy of mechanism which moves 8,778,581,061 of people one mile, and billions of dollars' worth of treasure in every direction across and along a continent in a single year, and supports a property representing $7,676,399,054 of securities, a single point for his admiration or even for his approval.

Archimedes had the world for a load and natural science for a lever; but even Archimedes was obliged to sigh for a place whereon to plant his fulcrum. It appears to me that, in this laborious work of five hundred closely printed octavo pages, what Mr. Hudson lacks most of all is a standpoint. He has a load, he has a grievance for a lever, but, since he can not himself float in space, he makes no impression on what he claims to be the burden to be moved. Mr. Hudson's want of standpoint is prominent at his very outset in his very title-page. He calls his book "The Railways and the Republic," thus antagonizing his two terms. But the grouping is vicious, to begin with; since railroads, whether regarded as legal entities or as companies of individuals, are as much part and parcel of the republic as is Mr. Hudson himself. Starting upon this false major premise, Mr. Hudson proceeds in the first of his eleven chapters to give us the indictment, the remaining ten to be the counts of the particulars.

The title given to this indictment, "The Problem of Railway Domination," is again illicit. Where is the "domination" to be eliminated? Frankly admitting that the present writer believes that railways belong to the persons whose money has built or purchased them, and that their *quasi*-public character is justified and satisfied by their honest performance, by the best methods that applied science up to date has furnished, of the duties of public transportation, he proposes from this standpoint to examine: first, Mr. Hudson's indictment as a whole, passing thereafter—as far as the limits of a single paper will allow—to the particulars exhibited.

According to Mr. Hudson, the railways of the United States either "dominate" at present, or propose sooner or later to "dominate," the republic. How? By being "gigantic monopolists," says Mr. Hudson. And how do they become gigantic monopolists? By being gigantic corporations, controlled by men of altogether too enormous private fortunes. Now, we have always known that a railway was a corporation, and that some of our railways might fairly be called "gigantic." But there is not one of these "gigantic" corporations which is, in any sense of the term known to dictionaries at least, a monopoly. To be exactly all-fours with the lexicographers, the only railways in the Union which are monopolies are countable on the fingers of one hand, and must be as insignificant in extent, capitalization, importance of terminals and every other characteristic, as they are in number. Everybody knows that a shipper or traveler from New York to any point in the United States has an abundant choice of routes before him. Whether his objective be Buffalo, New Orleans, or San Francisco, or any city or town large enough to make a dot on the map, or any one of the ten thousand points reachable from every one of these, there are certainly half a dozen lines of railway at his option; and if there are two points in the United States between which there is but one means of transportation, it is because the points themselves are of such exceedingly minor importance that a second means has entirely failed to be a temptation to local capitalists. I once happened upon a railroad on the top of the Alleghany Mountains, five miles in length, called the Wilcox and Burning-Well Railroad, running between a tannery and a saw-mill, which—as there was no other means of going from one to the other except by taking an axe and a compass and tempting the aboriginal forest—might, I think, be fairly called a monopoly, especially since the owner of the railroad was also the owner of both the terminal tannery and the terminal saw-mill. But the great majority of American railways are, just now, competitors rather than monopolists, and, if gigantic at all, are gigantic competitors. It is to be admitted, of course, that to construct, maintain, and operate a "gigantic" railway, gigantic corporations may not be unnecessary.

Now, railways "dominate," says Mr. Hudson, by being these gigantic corporations against which units have no chance. But just as capital is the storage of labor, so a corporation is the aggregate of units, and if units can combine to "dominate" other and uncombined units, why can not these other units combine to resist the domination? Mr. Hudson does not recognize such a question, suggests no device by which the unit unassisted by capital can equal in strength the unit when so assisted, nor any reason why the units incorporated for transportation purposes should not compete for the transportation business of the units not incorporated for transportation purposes. This word "competition," however, is no favorite of Mr. Hudson's. He immensely prefers "domination": and properly so, too, since in the employment of the latter word lie not only his premises, but the conclusions at which he assumes to arrive. The railways, concreted, "dominate" the republic (that is to say, all the United States except the railways), and therefore, since they "dominate" by doing the transportation business of those not in that business, the only safety is to reverse the situation, so that the units not incorporated for transportation purposes should hereafter dominate the units who are so incorporated. In other words: Let our railroads, by all means, be run by men who do not understand railroading, and let those who do understand the running of railroads step down and out at once.

But why should those individually concerned in railway management step down and out? Why, says Mr. Hudson, because several of them have accumulated enormous fortunes; fortunes fabulous, even when compared with all the other private fortunes in the world. But whence come these ten or a dozen (if so many) vast fortunes?

Why, says Mr. Hudson, with admirable circumferentiality, from the domination of railways. Clearly we must get this kernel out of Mr. Hudson's crop if we are to proceed with him any further: and to dispose of it may require a moment or two of our attention.

The greatest of powers, undoubtedly, is the human brain; and, so long as it is the instinct of man to scheme for his own aggrandizement, certainly the greatest brain will scheme to the greatest profit to himself. A dozen men in the United States have been able to amass, from management (or, if the word is preferred, manipulation) of the railway systems of the country, the largest single fortunes known to history: not in land, in interests in estimated wealth, but in actual comfortable, convertible cash, representing no manual labor of their own, no commensurate investment of capital, and no proportional benefit to the race. But, because Mr. Hudson is virtuous, are there to be no more cakes and ale? Because Mr. Gould is very rich, are there to be no more railway companies? Because these dozen fortunes are beyond any heretofore conceived relation of reward for personal industry, is the material by manipulation of which they have been accumulated, noxious, bad in itself, and dangerous to the common weal? These fortunes are, for our present purpose, the pure result of brain-labor, the rewards of pure thought. Let us leave out of the reckoning whether they are honest or dishonest fortunes; or, if Mr. Hudson prefers, let us concede them to be dishonest. The fact, the only fact, necessary to the discussion of his own questions on his own ground is that they have been accumulated by the purchase, manipulation, and operation of railways. The people make the laws, not the railroads. To argue that railroads, *quoad* railroads, are hateful to public policy, dangerous to the public peace, threatening to public morals, and destined in time to destroy the commonwealth, as private luxury once destroyed old Rome, seems to me the simple fallacy which logicians call an "undistributed middle." As well condemn any other thing because at some time something of its species has been manipulated to a personal and exorbitant profit. Banish corn, wheat, or coal, because great "corners" have been planned in those staples, and hundreds of thousands of consumers obliged to pay more than they ought to have paid, when a few schemers, who had schemed for months, had suddenly sprung upon these unsuspecting thousands their long-perfected plans!

Shakespeare makes one of his characters put the question, "How do men live?" and another answers it: "Marry, as the fishes in the sea, the big ones eat up the little ones." The struggle for existence which our brute ancestors carried on with teeth and claws and fangs, we still perpetuate with interlocked and grappling brains. They strove and tore and trampled each other for the food their bellies craved, *in specie;* we fight for values instead. But the result is the same: the strongest brain, as once the strongest limb, wins. And when, as within the last half-century right here in the United States, in what is scarcely more than the close of the first half-century of the railroad, a few phenomenal brains have amassed more of these values than their share, more than they can consume with their own personal wants—while I admit that the problem looks serious to those whose brains have not taken part in the struggle—the wrong seems to me one for which Nature, not art or science or schools, is at present mostly responsible, just as much as she is responsible for the lion that rends the ox, or the fox that pillages the farm-yard. The United States of America does not make treaties with individuals: and yet the treaty between the United States and the kingdom of Hawaii is, or was once, practically for the single benefit of one man. Why? Because there happens to be but one article of export from Hawaii to the United States; and because that one product happens, or happened, to be controlled by the brains and capital of one man. So this anomaly—this wrong, we suppose Mr. Hudson would call it—is to be charged to the crime of having brains, or to the domination of (not railways this time, but) sugar! Perhaps the situation can be made very clear to Mr. Hudson by a quotation from himself:

He says, page 1: "Watt could see in the steam which lifted the lid from the tea-kettle a force which might yield man some aid in his labors; but he could not foresee the immense application of that force to every phase of life. He could not dream of the millions of factories, the thousands of steamships, or the myriads of railway-trains that lay dormant in his discovery." And yet it is simply and solely because a human brain here and there did foresee what Mr. Hudson says Watt could not or did not—that massive fortunes, larger than an aggregate of thousands amassed by mere manual labor and economy, have been accumulated. Shall the owner of such a brain assume that Nature in so endowing him endowed him with a curse to his fellow-men, and that it is his natural or moral duty to devise a means of redistributing this accumulation to the two hundred thousand or hundred thousand millions who, like Watt, could not foresee? I do not so understand Mr. Hudson to urge; but perhaps he will be able to demonstrate to what other duty his satire on the men who, by building, buying, controlling and operating railways, amass vast properties, surely and implacably points.

The processes by which the fish with capital swallows the fish without capital—by which money attracts money, and foresight eclipses hindsight—stand possibly in bolder and nearer relief, just now, in the case of the three or five railway kings (whose fortunes may last another generation or two without division) than elsewhere. But, that they are processes unfamiliar in any given commercial undertaking or venture, I do not find any note in Mr. Hudson's indictment to assert. His indictment of railways and railway management is the constant and simple and single charge that they "dominate" the non-railway world by making the rich richer and the poor poorer; and this, principally, by piling up vast accumulations of wealth in the hands of the very few. Mr. Hudson is wary enough to see that railroads, not being *per se* illegal, the accident and consequence are not illegal; he, therefore, argues deftly that the railways, although legal, are illegally handled by their managers. This illegality he separates into five counts—that the transportation business, legitimate in itself, has been made pernicious to public and private rights, and "dominates" them by certain imported incidents, viz., by—

I. Land-grants.
II. Pools.
III. Construction companies.
IV. Rebates and discriminations.
V. "Fast-freight lines."

Mr. Hudson does not add to these—sleeping, hotel, and parlor-car companies, railway-lighting companies, and all the numerous other auxiliaries to modern railway management, which save the time and economize the capital, while they accommodate the patronage of railways. I know not why, but, since he has left them out of the indictment, we will follow his example. But Mr. Hudson does pause just here—by what logical process is not apparent—to fulminate to the length of many solid pages over and against the Standard Oil Company, its history, career, and the procedure by which, before the days of "pools," it was able to force favorable contracts upon the railways to its own vast advantage; accumulating thereby assets almost as enormous as either of the three or four private fortunes in which Mr. Hudson sees such imminent peril to the republic. As we are just now considering the railways, perhaps we might as well leave out the oil company. We may admit, I think, however, in passing, that the Standard Company was an accident—a thing by itself, like the moon or the Gulf Stream—from whose existence even a possibility of another cannot be predicated, since the present system of "pooling" associations would render its repetition practically impossible. Mr. Hudson is perfectly right in announcing that this great corporation is not a charity or an eleemosynary foundation of any sort; that it does business for the enrichment of its own stockholders rather than in behalf of those of its rivals; that it takes all it can get—is soulless, grasping, and selfish. That it has been engineered by men of brains until it has become in certain localities a practical monopoly may also be conceded. That, so long as the laws under which it is incorporated permit other incorporations for like purposes, it is a monopoly, legally or derivately speaking, I am afraid must be denied.

Premising merely that railways are not always the personal property of their officers, but that their ownership, as a rule, shifts with every sale of stocks made in Wall Street or on the 'Change of a dozen capitals—and that, in Mr. Hudson's formula (page 5), "of the existence of actual abuses in the railway system of the country there is little room for dispute," it were not impossible to substitute for the term "railway system of the country" the term "everything human" —let us pass to the counts of the indictment:

I. Land-Grants.—Of these Mr. Hudson says: "We might even make allowance for the men who, having received a gift of an empire of lands and money for the construction of a transcontinental railway, proceed to bribe legislators and buy up public officials to prevent adverse action as to the ratification of past donations. . . ." (page 6). "If the Government has secured the settlement of the Western Territories, the pacification of the Indians, and quick transit to the Pacific coast, by giving the men who built the transcontinental railways the money to build the roads, and an empire of land in addition, it is still permissible to ask whether it will not suffice to present the projectors of the next enterprise with the completed railroad, without adding the millions of acres of territory to induce them to take the gift" (page 8). This is hardly in what might be termed "the scientific spirit." But let that pass. The point is, does Mr. Hudson know what a land-grant is? In the free and buoyant West, where language is as bounding and breezy as its own prairies, a land-grant is often spoken of as a "land-grab." Mr. Hudson is more choice in his phrase, and calls it simply and grandly, a gift—a "gift of empire"—but his idea appears to be much the same. If the Government makes one a gift of land, that ought to be the end of it, by every principle of morality and justice, if not of politics. The Government is just as much bound by its gifts (barring the rule of construction to be noted) as any other giver. But Mr. Hudson says it is not a gift, exactly; but "a gift . . . for the construction of a transcontinental railway." Those who have tried it have been heard to affirm that "the construction of a transcontinental railway" is a matter of some considerable magnitude, requiring time, perseverance, and even labor. The Government, then, makes men a gift to build a transcontinental railway much as Mr. Hudson would make a builder a gift to build Mr. Hudson a house; and Mr. Hudson will even "make allowance for" men who will bribe legislators to prevent adverse action as to ratification of such a gift as that! Bribery is an intolerable crime; of all crimes most subversive of the public weal. But if bribery were ever, or ever by any possibility could be, justifiable as a last resort, it seems to me it would be justifiable to prevent adverse action by legislators who were determined to prevent the Government from ratifying a gift of land to men who had relied upon its honor and good faith even to such a trifling extent as to build a mere transcontinental railway! If the Government gives Mr. Hudson land, surely it ought not to take it away again, ratified or unratified. But, if it it gives him land in consideration of labor and services rendered and material furnished, and he deliver the material and perform the labor and services, surely he ought not to be put to the peril of the Government's refusal to ratify the gift, or to the expense of bribing legislators. But if Mr. Hudson had received a gift of lands (and even "an empire" is not—some who have attempted it say—too great for the task) in exchange for the construction of a transcontinental railway, from the General Government, I think, on reflection, he would consider himself harshly treated if, on constructing the same, the Government should withhold ratification of its gift. And if Mr. Hudson, why not a railway company?

But what is a land-grant, or "gift of an empire," since Mr. Hudson prefers that term? To begin with, it is a devotion or dedication of a certain portion of the public domain to railway purposes. Instead of purchasing it at two or three dollars an acre, the railroad company purchased it by building a railroad; not where and when they pleased, but between certain points, perhaps even through mountain-ranges, no matter how great the difficulties or how costly the construction, tunnels or viaducts, banks or bridges; not at their leisure, but in good faith as nearly within a specified time as human industry and allowance for the uncertainty of human events, financial and physical, would permit. Surely, this is no "gift" or "grab," to begin with. But, on building this railroad, does the land thus "given" become the property of the company? Not yet. There are other details; the land must be surveyed by Government surveyors, and the company must pay the cost of the survey in cash before it can take possession. Even Government surveyors do not work for nothing, and land in its native wildness, where human foot hath scarcely trod, is not apt to recoup much of engineering expenses. Nor is this all. If there happens to be upon the "empire" of land (which is granted by the square mile, and without reference to any map, or former record of grant, by general description in terms of quantity only) any acre or plot already occupied by an individual, Indian tribe, or other company, does the Government guarantee its own "grant of empire" given to this company as a consideration for the labor, services, and material it has exhausted in building a transcontinental railway? Strange as it may seem, the Government not only does nothing of the sort, but in its own general land-office sits as arbitrator between this earlier proprietor or these earlier proprietors and its own grantee, upon its own grant; and appeals to the rule (first laid down by Lord Ellenborough) that, whereas a private grant is to be construed strictly against the grantor, a public grant, from a state to a subject, is to be construed strictly against the grantee! This matter (in which the Government's grantee is made that unusual character, a defendant with the burden of proof) is tried before the grantor Government, is heard by the commissioner whose decision is to be affirmed or reversed on another hearing before another employé of the grantor, the Secretary of the Interior. Or should the contesting proprietor or alleged proprietors elect to begin his or their action for trespass in the local State or Territorial court, it can be carried step by step up to the Supreme Court at Washington. As a matter of fact the reports of this court teem with these cases, wherefrom the reader can imagine something of the routine litigants have undergone to get there. All these hearings and rehearings, appeals and new trials, and further appeals, have to be attended and argued by counsel in behalf of the Government's own grantee, the defendant company. And since, should the company finally secure its title to the land the Government had already granted it, it can only sell it for two or three dollars an acre, and lawyers' bills are not apt to be prepared on a *diminuendo* scale, the public mind can now begin to appreciate how recklessly magnanimous a "gift" this land-grant was on the part of the Government, and the extent of Mr. Hudson's charity in being able to "make allowance" for the recipients!

But the above is not all. This gift, Mr. Hudson himself admits, has to be ratified, and legislators bribed to ratify it. He would come nearer the truth did he assert that it has to be ratified at every session of Congress. I have in my mind a company whose land-grant was received considerably more than twenty years ago, and which has earned it by building and operating its entire road, and yet I doubt if the lawyers of that company could, without considerable research, mention a year in which that grant had not been a matter of attack upon the floor of Congress. Nor is it yet at rest there, although that road is operating over three thousand miles of trackage. Mr. Hudson says that the men who receive these dubious "gifts of empire" "bribe legislators and buy up public officials," to prevent adverse action as to the ratification. Doubtless he knows of what he speaks. Our legislators are elected by the people, and to the people they are responsible. But the fact that our legislators do not, as a rule, allow land-grant questions to rest, and are constantly demanding adverse action, even in cases as old as the one I have just referred to, does not look as if land-grant companies had largely added to the expense of receiving their already costly present of lands by large "bribes to legislators and purchase of public officials"; for certainly they have not prevented adverse action upon these grants to any very memorable extent.

Mr. Hudson speaks of money-grants as well as land-grants to a transcontinental railroad. In the throes of a bloody civil war it is to the eternal credit of one patriotic Congress that it did vote a loan to a transcontinental railway company to enable it to connect the shores of two oceans whose communications otherwise were at the mercy of pirates and privateers, fitted out by a rival nation, interested in driving our commerce from every sea. But, with the necessity, the policy ceased forever. In other cases, to make their heavily purchased "gifts" available, the plan of mortgaging them was resorted to. They have been so mortgaged, and, on the faith of the Government, the bonds secured by these mortgages are now held by this people;

this republic—whose enemies, Mr. Hudson will have us believe, all railways are. Nor is it a figure of speech to say, in this case not only, but in every case of a railroad upon which a mortgage is spread, that so far from the railway being the enemy, it is the creature of the republic, for the republic is the people, and the people, by owning the securities of a railway, own the railway itself. Mr. Hudson may fire the popular heart of the non-investor by his periods; but if, perchance, he desires more than this, he can not yet claim to have found either a place to stand, or a fulcrum for his lever.

II. Pools are combinations of railways at once with and against each other, never against the public, or (if Mr. Hudson prefers) the republic. The name is unfortunate, as suggesting a pot or lump, whereas, in fact, the pool is an elaborate system of differentiation and equating, by which railroads practically pay into the pool, not their lumped receipts, but percentages thereof. These pools are the legitimate and necessary results of the rechartering over and over again of railway companies to transact business between the same points, by paralleling each other. So long as the people in their Legislatures will thus charter parallel lines serving identical points—thus dividing territory they once granted entire—it is not exactly clear how they can complain if the lines built (by money invested if not on the good faith of the people, at least in reliance upon an undivided business) combine to save themselves from bankruptcy. Without such combination the strongest company must bankrupt and "gobble" the others, which survival of the fittest would be exactly what Mr. Hudson declaims and deprecates—a Monopoly; and this time a most grasping and cruel one, since the first aim of the surviving road must logically be to recoup itself for the tremendous expenses of the "gobble" by extravagant overcharges! Had a pooling system existed at the date of its birth, the Standard Oil Company octopus could never have grown up. And it is interesting reading—as Joe Gargery would say—to find our Mr. Hudson snarling on one page at railways because they render such monopolies as the Standard Oil Company possible, and, on the next, cursing pools as against public interest. And not only are pools safeguards against private monopolies, but, as against the "tie-up" and the boycott, bound to become the needed, possibly the only, antidote if not the only relief. possible. Individuals may, and no doubt do, from geographical conditions, suffer from the absence of competition which pools guarantee. Doubtless a shipper at Buffalo could make better terms to New York were five trunk lines engaged in the suicidal pastime of cutting each other's throats. But the greatest good of the greatest number is subserved by an honest rate, and that the pool secures to it.

III. Construction companies are conservers of time and capital at once to the public and to the railway-builder. If a railway between two given points be needed at all, it is needed as soon as possible.

The construction company, by procuring the capital, obviates the delay of resorting to individual subscriptions, and the dilatoriness of small subscribers; and, by securing a rapid building and equipment of the desired road, serves the public by affording them early transportation facilities. And if, at the same time, it secures the stockholder and builder by relieving against the reasonable probability that a railroad built to develop new territory would pass into the bondholders' or into a receiver's hands before the territory could be developed, the benefit to the stockholders ought not reasonably to be considered an offset to the benefit to the shippers.

IV. Rebates and discriminations are neither peculiar to railways nor dangerous to the "republic." They are as necessary and as harmless to the former as is the chromo which the seamstress or the shop-girl gets with her quarter-pound of tea from the small tea-merchant, and no more dangerous to the latter than are the aforesaid chromos to the small recipients. The trouble Mr. Hudson finds with them is that the railway systematizes them instead of granting them at random or for sentimental reasons. The *quasi*-public character of railways, he thinks, should make these rebates illegal. The railway, in exchange for its right of eminent domain, should listen to the wants of the whole people instead of to individuals. Undoubtedly. But the whole people are not shippers over any one railroad; nor does any one railroad draw its revenue from the whole people. Of course, I am proceeding upon the supposition that the United States Government does not propose to become a gigantic railway corporation, and add to its legislative, judicial, and executive functions the operating of 125,379 miles of railway, with a funded debt of $3,669,115,722. Did "the republic" undertake such a task, does Mr. Hudson, after reading his own book, believe that there would be no rebates or discriminations extended to anybody for political, economical, or social purposes?

V. The subject of "fast-freight lines" might well be dismissed in the same breath, these being a financial consideration entirely between the companies and their stockholders. It may be noted, however, that they are public accommodations, affording to large parcels the safety, care, and prompt delivery which express companies afford to small ones, and that, like the express companies, they have grown to be public necessities. They not only secure the delivery of freight at destinations beyond the receiving line, but have introduced new amenities into civilization by distributing products. By their aid the New-Yorker finds daily on his table the fruits of California, or the glorious beef from Texas grazing; and the dweller in the lake-shore States his sea-food, as if each had changed places with the grower and gatherer. Nor do the figures show an increase, but, paradoxical as it may seem, a substantial decrease in tariffs on non-perishable freights by their means.

Stripped of declamation, this is all there is of Mr. Hudson's counts:

the result being, that while railroads are not philanthropic or charitable bodies, organized for good works among the poor and needy, they are not basilisks, or gorgons, or minotaurs, destroyers of the state or dragons that feed upon the people. And now we might well leave Mr. Hudson and all his works, were not his lack of standpoint just here so ludicrous as to tempt from us a further word. He cries (page 9), "Railway projectors have invariably embarked in these enterprises, not so much for the public welfare as for their own private enrichment." What else had Mr. Hudson been led to suppose? The millennial state in which private enterprises are conducted for public ends is certainly not yet a State in the Federal Union, wherever else on this planet it may be discovered. Mr. Hudson's next proposition is that, "if the country has had hundreds of millions added to its wealth by railway construction, the builders have also secured tens of millions for their individual fortunes." In any but the millennial state one would think that a free gift to the commonwealth of ninety percentum of one's profits was a rather liberal tithe, and an exceedingly handsome thing. Most private parties, certainly most governments, would open their coffers to their friends on the same terms. But Mr. Hudson is ashamed to think that private capital, enterprise, patience, and labor should have been returned anything. Clearly, the Government should take fully cent per cent for the industry of its subjects.

"While the nation has gained in wealth and population by the general extension of railways," says Mr. Hudson, "it does not follow that the wealth could not have been more justly distributed if railway management had been universally governed by the principles of equity" (page 8). What wealth? Mr. Hudson was just now complaining that the entire benefit did not go to Government, and that the individual received ten per cent. Now he regrets that it was not even more widely distributed among individuals. What are Mr. Hudson's views as to the meaning of the word "equity"? Would "equity" have been subserved if the ten per centum or the hundred per centum were distributed by lot, or on a basis of pauperism, or covered at once into the treasury of the republic? The statements that "the equality of all persons is denied by the discriminations of the corporations which the Government has created"; that "under them the increase of national wealth is not distributed among all classes according to their industry and prudence, but is concentrated among those who enjoy the favor of the railway power"; and that by means of railways "general independence and self-respect are made impossible" (page 9), may perhaps be passed over with the remark that if Mr. Hudson himself believed in propositions as silly as these, to argue with him at all would be like reading Herbert Spencer to the Salvation Army.

It is a *bonne bouche* to bring into the discussion at this point an allusion to the riots of 1877 in lurid juxtaposition with the French Revolution; but—since, wherever planted, the roots of neither of these cataclysms lie in land-grants, construction companies, pools, rebates, or fast-freight lines—it need not detain us here. I have not touched in this paper upon the "Granger" cases (so called), my limits forbidding. But I do not understand that the principles enunciated in them conflict with any of the statements I have made. I lately had the pleasure of perusing a learned article in an English magazine which proposed that railway companies, like post-office departments, make rates independently of distances or extent of services rendered; or at least establish two rates, "one for short distances and others for long distances: so much for every distance not exceeding one hundred miles, so much for every distance between one hundred and three hundred miles, and so much for all distances exceeding three hundred miles, keeping the one rate for all distances in view as the ultimate object." It seems to me that, if gentlemen who write in this fashion expect their papers to be read, they expect all they are entitled to. Similarly, I think that Mr. Hudson's loving treatment of the ancient claim that, since railways are public highways, any citizen has a right to send his own limited express along the line at any moment on payment of a trackage-fee, ought to stamp the value of his criticism. But since many of his terrors do very widely obtain among conscientious men, I have thought to attempt to allay them. Mr. Hudson's book is printed on better paper and more nicely bound than the usual socialistic attack upon things as they are. But that he is, or is destined to become, the long-looked-for reformer of the American railroad, I fear can hardly be hoped.

A MOUNT WASHINGTON SANDWORT.

By GRANT ALLEN.

WE were not fortunate with our plant-hunting on Mount Washington. Perhaps, for want of a local botanist to show us the lurking-places of the rarer species, we did not succeed in finding all of them. But some of the most interesting to a British naturalist could be gathered everywhere without the trouble of seeking. When the little, puffing, oblique locomotive that drags you up from Marshfield to the summit stopped awhile to rest and refresh itself after its steep climb up Jacob's Ladder, we jumped out eagerly upon the surface of the mountain; and there, among the erratic bowlders of the Great Ice Age, I lighted at once upon broad beds of two plants my eyes had never before beheld in the living state—one, a pretty tufted White Mountain sandwort, and the other a beautiful bright golden avens. So thickly did they cover the ground on that high shoulder of the great ridge, that all the passengers were filling their hands with big nosegays to carry away as mementoes of the mountains. The sandwort in particular starred all the crannies among the rifted rocks with its delicate blossoms, and brightened up the otherwise bare and forbidding soil with the mingled green and white of its densely tufted bunches. *Arenaria Grœnlandica* is its scientific name—a name that tells at once the better part of its curious history; for this little plant belongs by rights to the frozen shores of far northern Greenland, and the little colony that lingers on here in the clefts of the rock has lived on the chilly summits of the White Mountains ever since the close of the Glacial Epoch.

There are many other flowers on the slopes of Mount Washington far more full of interest to the American botanist than this Greenland sandwort, because far more isolated in the New World, and far more difficult for him to find elsewhere. The sandwort occurs abundantly on several other mountain-summits in the States, being found on the Shawangunks, the Catskills, and the Adirondacks, as well as in the Green Mountains and on the higher peaks round Lake Memphremagog. At Bath, Maine, it even appears on river-banks near the sea, and farther northward, in Labrador and Greenland, it becomes a common plant of the plains and uplands. But the Alpine brook saxifrage (*Saxifrage rivularis*) confines itself in the States entirely to Mount Washington, as its beautiful congener, the purple saxifrage (*S. oppositifolia*), does to the rocky crags of Willoughby Mountain in Northern Vermont. So, too, the little creeping mountain potentilla of the Scotch Highlands (*Sibbaldia procumbens*) is only found in the United States on the Presidential Range of the White Mountains. There are many of these Alpine or sub-Alpine plants which the American botanist can pick here, and here only, unless he chooses to wend his way to the frozen shores of the far North in chilly Labrador and the Hudson Bay Territory. Yet, to the English naturalist, they are comparatively uninteresting, for they form part of the common European mountain flora, which reappears on all the higher peaks of his own continent, from the Alps and the Caucasus to the Norwegian fjelds and the Scotch Highlands. To him, then, these two native American upland plants present far more numerous points of interest, because this is the only place in the civilized world where he can hope to find them ready to his hand, as representatives of the truly northern New-World flora.

The general aspect of vegetation on the higher levels of the White Mountains, indeed, is distinctly subarctic, or, to give its truer name, as I prefer to say, glacial. Besides the common sun-dews and the grass of Parnassus, which always follow the upland bogs of northern climates on both sides the Atlantic, Mount Washington and his neighbors possess a large number of chilly plants, like the Norwegian cloudberry (*Rubus chamœmorus*), the Alpine willow-herb (*Epilobium Alpinum*), the dwarf rattlesnake-root (*Nabalus nanus*), the mountain cudweed (*Gnaphalium supinum*), the bog bilberry (*Vaccinium uliginosum*), the Alpine bearberry (*Arctostaphylos Alpina*), and the Lapland phlox (*Diapensia Lapponica*). Some of these, and others like them, were old friends already familiar to me on European mountains; but some were fresh American acquaintances, whose faces I was glad indeed to see on these bald summits. Both types, however, were alike in their thoroughly northern and almost arctic aspect; they were the plants of Greenland, of Finland, of the North Cape in Norway, of frozen Rupert's Land, of equally frozen Siberia. Some of them were common to both hemispheres, some were peculiar to the New World, but all, indiscriminately, were members of that same old circumpolar flora which came into being at the extreme end of the Pliocene period, when the world was just beginning to cool down at its extremities for the long secular winter of the Glacial Epoch.

Traces of that gradual cooling down are by no means wanting in the geological deposits of either hemisphere. The Pliocene period, as a whole, both in Europe and America, was an age of warm and genial climates, of large and vigorous animal types, of rich, sub-tropical-looking vegetation. In the Red and Norwich crags of England, for example, we find the remains of mastodons and elephants, of hipparions and hyenas, of the hippopotamus and the rhinoceros, of the tapir and the horse. In the rich leaf-beds of the nearly contemporary Vienna basin, we meet with a correspondingly warm sub-tropical flora—a vegetation abounding in sequoias, liquidambars, and chestnuts, fragrant with cinnamon, laurel, and tamarind. In the Loup River beds of the upper Missouri region, again (Professor Marsh's "Niobrara group"), America possesses similar mammalian remains of tropical and almost Oriental character—a tiger larger than the Bengal beast, an elephant, a mastodon, several rhinoceroses, and the earlier sketchy prototypes of the camels and the horses. The period when such warm-weather creatures flourished in such northern latitudes must surely have been one of very genial climatic conditions. But, toward the close of the Pliocene age, mutterings and forewarnings of the great glaciation begin to show themselves, and to herald the advent of that vast ice-sheet which gradually swallowed up in its devouring bosom the better portion of either continent.

Already in the Norwich crag of England the evolution of such northern molluscan species as *Scalaria Grœnlandica*, *Panopœa Norwegica*, and *Astarte borealis* (whose very names attest their arctic habits in our own day), gave evidence of a slow but certain lowering of the world's temperature. Nature only produces these cold-weather types where the surrounding conditions have rendered the change absolutely necessary. In the somewhat later Chillesford beds, the great invasion of arctic kinds begins in earnest; about two thirds of the shells whose fossil remains form the fauna of the period still survive in high northern waters. Slowly, as the period of greatest eccentricity drew nigh, the ice-cap began to form around the north pole. From the Arctic Ocean, the great sheet of solid glacier descended over Canada and the Eastern States till all New England, New York, and Pennsylvania lay covered with five thousand feet thickness of unbroken crystal. The ice cleared all animal and vegetable life off the face of the earth wherever it rested, and drove before it the old arctic fauna and flora as far south as Maryland, Virginia, and Kentucky. After many minor chances and changes, however, brought about by the recurrent cycles of summer and winter in the northern and southern hemisphere alternately, the world's weather began slowly to improve again. Step by step the ice retreated northward once more, till at last only the comparatively insignificant polar cap remained to bear witness to its sway, with a few casual southern extensions, like the one that still envelops all upper Greenland in its desolating sheet. As it slowly retired, the arctic fauna and flora followed close in its rear, on both sides of the Atlantic, till nowadays the plants and animals which once covered the plains of Europe, Canada, and New England find their last home in Spitzbergen, Nova Zembla, and the extreme northern shores of British America.

They left behind, however, some tokens of their presence to the present day even in the lower latitudes of Europe and America. The Greenland sandwort, among the New Hampshire hills, is just as much a relic of the Glacial Epoch as the striated rocks, the erratic bowlders, and the coarse drift which the Great Ice Age stranded high up the slopes and corries of Mount Washington, where we still find them in our own times. All the other glacial species (including that rare White Mountain butterfly which occurs on the very summit of that one peak, and nowhere else south of Labrador) have struggled on side by side with it, in isolated colonies, from the days when the ice retreated northward to the present moment. But there is a great difference in this respect between Europe and America, as Dr. Asa Gray has well pointed out. With us, in the Old World, great lateral ranges of mountain—Alps, Pyrenees, Dovrefjeld, and Caucasus—still nourish large existing glaciers and snow-fields, the lineal descendants of the universal ice-sheet of the Glacial Epoch. Hence, our European mountain flora, and, to a less extent, our mountain fauna as well, are even now large and flourishing; they retain a marked arctic appearance, and recall all the well-known stunted features of the glacial assemblage of plants and animals. The snowy mountain regions have acted as continuous nurseries for the dwarfed vegetation of the Great Ice Age. In America, on the other hand, you have few hills of any size east of that great backbone of the continent, the Rockies, and none of these hills rise to anything like snow-level. Hence, your mountain flora is, on the whole, but a poor one, and most of the species are the familiar kind which the European botanist already knows well among the Swiss Alps and the Scotch Highlands.

Mount Washington, indeed, though the highest of all your Northeastern peaks, is not by any means the best station in the States for the plants of this old stranded glacier stratum. As you go from New York to Montreal by the Memphremagog route, you pass near St. Johnsbury a little station named West Burke, whence stages carry you in a few miles to Willoughby Lake, one of the loveliest among all the lovely sheets of water with which Northern Vermont is so copiously dotted. The hills surrounding Willoughby Lake are rich in mementoes of the Glacial Epoch. There, alone in the States, thanks to combined latitude and elevation, the American botanist can pick at leisure the beautiful tufted mountain saxifrage that purples with its bloom the Highlands of Scotland in early spring. There, too, grows its pretty yellow congener (*Saxifrage aizoides*), a circumpolar species of both hemispheres, which descends in Europe as far south as the Cambrian lakes. The Alpine rock-cress, the hoary whitlow-grass, the purple astragalus, and many other high northern species, are also almost confined in the States to Willoughby Mountain, though reappearing far to the north in British territory—either Canada or Newfoundland. Mount Katahdin, in Maine, ranks next as a refuge for many good glacial species, including the beautiful little starry saxifrage (*Saxifrage stellaris*), whose slender blossoms spread in countless numbers beside the rills and streams of the Scotch Highlands.

Naturally, however, to a European visitor, such a plant as the Greenland sandwort possesses a far deeper interest and importance than these old friends of the Swiss or Scotch uplands. It is a native American, local to the soil ; or, to speak more correctly, a rare example of a glacial plant which has died out in distant Europe in spite of the superior advantages there afforded to Alpine or sub-arctic species, while it has lingered on in vigorous colonies over all the fitting districts of America, from the riks of Greenland to the Catskills of New York. Nay, more, in a slightly altered and adapted form, as the *Arenaria glabra* of the systematic botanists, it has held its own even as far south as the mountain-tops of Carolina—a glacial strayling stranded almost alone on the chilliest summits of a sub-tropical land. The Carolina type, as might naturally be expected, is a larger, handsomer, and more luxuriant plant than the New Hampshire and Greenland variety, but it does not differ in any point of real structural or systematic importance from its pretty little sisters of more frozen climes.

Very much the same thing is true of our other common Mount Washington flower, the yellow avens that grows so abundantly in and out among the thick-set beds of Greenland sandwort. This, too, is a thorough-going native American type, though not a type of glacial antecedents. What gave it its deepest interest in our eyes was the very fact that, growing as it did side by side with those sub-arctic plants, the bog-bilberry and the mountain saxifrage, the Alpine bearberry and the Lapland phlox, it yet exemplified the other main element of the American upland vegetation—an element intrusive from the southern mountains rather than from the circumpolar and northern plains. For the avens is, in fact, a New England mountain variation on a pretty plant which covers the higher Carolina hills—*Geum radiatum* of Michaux, a hairier representative of the self-same type. The more northern outlier, known as the variety *Pechii* of Pursh, has smoother leaves and somewhat glabrous stems, but otherwise keeps up the general characteristics of its Southern congeners. Just so, on the slides above the Notch of the White Mountains, not far from the Willey House, I found in profusion another essentially Southern plant —the *Paronychia argyrocoma*, a silvery looking whitlow-wort, whose inconspicuous blossoms, allied to those of our European knarvel, are yet rendered beautiful and noticeable to mountain insects by their numerous thin and shining scarious bracts. This curious plant, one of the most suggestive I found in America, is not known to occur anywhere else in the far Northern States save in this one deep and secluded valley. But, among the Alleghanies, it occupies every breezy summit from Virginia southward, so that it belongs, like the Mount Washington avens, to the sub-tropical mountain flora, and only makes its appearance, as if by accident, among the glacial vegetation of the New Hampshire hills.

How did these isolated Southern species come to obtain a footing in such bleak situations near the northern limit of the United States? Doubtless, in the first instance, their introduction was due to the agency of casual birds, who must have brought the seeds with them, clinging to their feet or legs, on their annual migration from their winter dwelling-places. Once fairly started on the New Hampshire mountains, they succeeded well because naturally adapted to their new situation, where the summer heat would not be far inferior to that of their native Carolinian heights, while the snow-sheet of winter would amply protect them from the killing effects of December frosts.

And this brings us back once more to the point from which we started—the history of our little Mount Washington sandwort. Nothing was more noticeable, as we mounted the slopes on the cog-wheel railway, than the wide sheets of conspicuous blossom that greeted us everywhere with their striking mass. First of all, it was Canadian cornel in broad patches that whitened the soil; then it was great areas of the Greenland sandwort; and then golden spaces of the yellow avens. Now, all the world over, mountain-plants, especially those that grow beyond the limit of trees, and close up to the very snow-line, are celebrated for their exceptional display of vivid color. Everybody must at least have heard of the Alpine gentians, globe-flowers, and daffodils, that belt with blue or gold or primrose whole zones of mountain-side in Swiss spring-time. Exactly the same thing is true of the arctic flowers; short as is their summer, they make it beautiful while it lasts, with their profuse bloom, a hundred times more vivid and pervasive than anything to be seen in those much overpraised and misrepresented tropics. Even in temperate Europe and America, everybody must have noticed that, as we go up the higher hills, we find their slopes purpled with heather or golden with gorse, pink with mountain-laurel, or crimson with masses of the wild rhododendron.

Why is this? Simply because among the uplands and more especially close to the snow-line, bees are rare, and the work of fertilization is mainly left to the care of butterflies. Now, the bee, as everybody knows, is a steady, regular, business-like worker: he flies low, hunts close, never mixes his liquors, sticks steadily to one kind of honey produced by one species on each journey, and looks carefully for his selected blossom in and out among the tangled vegetation of meadow or road-side. Hence the flowers that specially cater for his peculiar tastes are more remarkable for their exact adaptation to his size and shape than for any conspicuous floral display. But the butterfly, on the other hand, is well known to be a fickle, flitting, fantastic creature: he flies high from bunch to bunch of large and noticeable bright-hued flowers. Above all other members of the insect tribe, he is a lover of color: big patches of red or white or purple are the things to attract him from a distance with their massive glare, and to draw him down from his careless flight in the eye of heaven. Hence butterfly flowers generally grow in huge trusses, massed closely together to re-enforce one another's effect; and they produce the finest total displays of any species known to humanity. On the hill-tops, and especially close above the limit of trees, the high-flying butterflies have things all their own way. The plants that affect these chilly situations, therefore, have before been compelled to accommodate themselves to the circumstances, and to trust for fertilization to the stray attentions of the casual butterfly. It is not without reason, then, that on the summit of Mount Washington a specialized and peculiar glacial butterfly should still accompany the specialized and peculiar glacial flowers.

Our Greenland sandwort, indeed, may be taken as a very good representative of the qualities necessary for ultimate success in a high-mountain plant. It grows low, in densely tufted masses, unlike the majority of its family, the *Alsinæ;* and thus it escapes both the rapid winds that career so madly round the summits of the Presidential Range, and the frosts of winter from which the snow efficiently protects its humble branches. Its blossoms rise in immense numbers from every tuft, so as to whiten the ground wherever it grows; and the petals are immense for the size of the plant, to act as an advertisement to the passing butterfly. Turn from it for a moment to the beautiful moss-campion (*Silene acaulis*) which grows close by among the crannies of the Mount Washington rocks, and you get a precisely similar assemblage of mountain features. That dainty little plant is tufted like a moss; its leaves are as crowded as those of the sandwort, and similar in shape, for like conditions always produce like results; and its purple blossoms grow in exactly the same wild profusion, making the whole plant, during the flowering season, into one low mat of brilliant bloom. The moss-campion is a perennial, and its close habit and much-branched, creeping stem protect it from the severe winter of New Hampshire, as from the Scotch snows and the frosts of Switzerland. We have in Europe another precisely similar plant, the Alpine lychnis, which one might almost at first sight confuse at a distance with the moss-campion, so absolutely have they accommodated themselves in the same way to the same environment; and this pretty pink flower, with its compactly clustered heads, has survived only on two hill-tops in the British Isles—Little Kilrannoch, a mountain in Forfarshire, and Hobcartin Fell, one of the least visited of our Cambrian heights. Compare the case of the glacial American species which still loiter round Willoughby Lake, or on the frozen heights of Mount Katahdin in Maine.

Every one of these mountain-plants exhibits in perfection the selfsame familiar mountain characteristics. Take, for example, the white dryas (*Dryas octopetala*), a species of interest to American botanists from the fact that in Pursh's time it still grew among the White Mountains, though it has now disappeared entirely from the United States, and can not be discovered south of Lower Canada. (Such local disappearances, by-the-way, are everywhere common, more than one rare local plant having been expunged from the British flora within my own memory.) The dryas is a dwarf and matted perennial herb or undershrub, growing in tufts just like the moss-campion, and with starry white flowers to match the Greenland sandwort. Its short and much-branched stems creep close upon the ground; the prostrate branches are crowded with dense foliage in spreading tufts. The species, in fact, with the rest of its kind, is but a specialized mountain form of avens; and its flowers are white, not yellow, like most of the avens group, in special adaptation to the butterfly taste; for it is a noteworthy fact that many genera which are yellow in the lowlands tend to produce white and purple species when they rise among the mountains or near the Arctic Circle.

The moss-campion is a pink by family, while the dryas is a rose. Now look once more at a member of a totally distinct order, the Lapland phlox, which also grows among the ice-worn bowlders of the Presidential Range. The phloxes as a whole are tall and handsome, large-leaved plants; but the mountain kind (*Diapensia Lapponica*), that still lingers on among the New Hampshire heights and the higher Adirondacks, is an Alpine dwarf evergreen, growing in the regulation dense convex tufts, a perfect mat of intricated leaves, from whose little rosettes rise solitary large white blossoms, as handsome as the dryas, and not unlike it in general effect. Anybody who cultivates rock-gardening, indeed, must be thoroughly familiar with this curious mat-like habit of the northern mountain flora ; for many of the saxifrages, alyssums, arenaries, and stone-crops which form his favorite masses of bloom are members of this truly Alpine and sub-Arctic vegetation. Often their very names betray their origin : lovers of rock-gardens will know what I mean when I mention such cases as *Erinus Alpinus*, *Lychnis Lapponica*, *Sedum Kamschaticum*, *Alyssum montanum*, *Silene alpestris*, *Dianthus petræus*, *Saxifrage nivalis*, and *Arenaria montana*.

Nor is it only herbaceous species that undergo this curious dwarfing and acquire this strange matted tuftiness, in order to meet the needs of high Arctic and Alpine situations. Trees and bushes have similarly to accommodate themselves to the exceptional conditions of the snow-line and the region just below it. Every tourist who goes up Mount Washington must have noticed how, near the limit of arboreal vegetation, the pines and spruces grow shorter and more stunted by slow degrees, till at last they disappear altogether from the scene. But even after they are gone, so far as the naked eye is concerned, they persist in part for the eye of the botanist. Three dwarf willows, for example, occupy the summits of the White Mountains, beyond the so-called limit of trees. All of them are prostrate, matted, and Alpine in type ; none of them rises above the general level of the herbaceous vegetation in whose midst they are found. The first, known as Cutter's willow, may also be gathered among the other higher mountains of the extreme Northern States, such as the Adirondacks and the Maine ranges. The second, the silvery-pointed willow, a very pretty plant of glossy, satin-like sheen when young, is confined to the moist Alpine ravines of the White Mountains themselves. The third and most dwarfish species of all, the herbaceous willow, has lost all resemblance of its descent from what was once a forest tree, and has degenerated into a rare ordinary herb, seldom rising above an inch or two from the ground, but still producing from its terminal buds the tiny catkins which keep up the memory of its former high estate. This last degraded scion of the willow stock, which creeps and roots underground for considerable distances, is common to both sides of the Atlantic, being found also in the Alps and Pyrenees, as well as in Arctic and sub-Arctic Europe : but the White Mountains are its only known station in the United States.

It is interesting to note that just the same dwarfing of the trees and shrubs took place everywhere during the fiercest rigor of the Glacial Epoch. In the little bed of glacial clay, containing plant remains of the Great Ice Age, on the coast of Norfolk in England, we still find the leaves of a tiny, shrubby birch (*Betula nana*), which grows even now in the Highlands of Scotland and in Scandinavia, attaining there at times to tree-like size, but which dwindles near the

Arctic Circle to a mere dwarf ; and it is the dwarf form whose leaves occur among the glacial *débris* of the Norfolk clay-bed. Side by side with it we find the scanty remains of a stunted northern willow (*Salix polaris*), another of the numerous pygmy shapes which the polymorphous willow type knows so well how to take on under fitting circumstances. It is hard, indeed, to conceive how anybody could ever have watched the gradual stunting of the trees and shrubs, as we ascend a mountain, or approach the Arctic Circle, and yet believe in the separate and deliberate creation of dwarf forms for such great altitudes or high latitudes, like the Mount Washington willows or the polar birch. If we trace the gradual degeneracy of the temperate birchen type, represented by the beautiful American silver or paper birches, through your own shrubby *Betula purinla* of the Northern bogs, and your petty *Betula glandulosa* of the high mountains, to the insignificant *Betula nana* of the arctic regions and of glacial times, it is impossible not to recognize in the entire series one long degradation of a primitive form. Similarly in the willows : every intermediate step may easily be identified, from the large and handsome weeping-willows, through shrubby forms like *Salix Lapponum*, *Salix refens*, and *Salix myrsinites*, till we reach at last the final term in the tiny *Salix herbacea* of the White Mountains. All are species degraded from a tall and vigorous ancestral tree by the harsh conditions which prevailed at the coming in of the Glacial Epoch.

The shrubs, of course, have fared no better than the forest-trees ; but, like the forest-trees themselves, and the lowly herbs, they have learned to accommodate themselves to the situation. Thus the bramble kind, after growing down from the high blackberry and the black raspberry to the level of the trailing dewberry (*Rubus Canadensis*) and the dwarf raspberry (*Rubus trifloms*), reaches at last an almost herbaceous type in our British *Rubus saxatilis*, and finally ends in a mere herb, no bigger than a strawberry-vine, in the true cloudberry of the arctic regions and the New Hampshire hills. So, too, the cornels, starting with your glorious flowering dogwood (*Cornus florida*), which alone is worth a visit across the Atlantic to see, ends at last in the pretty little bunchberry (*C. Canadensis*) that carpets the woodlands of the high North. And so, once more, the heath family, starting from the noble rhododendron and mountain laurels that glorify and brighten your American hills, tails off at last into the low, spreading, and tufted bog-bilberry, confined entirely to Alpine tops on both sides of the water, and to the mountain bearberry, whose low mats cover the interstices of the rocks among the White Mountains and the higher Maine hills. Everywhere the habit of all these sub-Arctic and glacial plants is just the same, whether their ancestors started in life as trees, or shrubs, or bushes, or herbs ; the Alpine azalea is as low and as tufted as the crowberry that mimics it ; the Labrador tea is as tiny and as inconspicuous as the Greenland sandwort. On all of them has fallen the blight of a terrible winter, never yet removed; and all struggle on among the chilly mountains and the northern snow-fields in virtue of that very constitution and character which they derived from their ancestors of the Glacial Age.

BIRDS AND THEIR DAILY BREAD.*

By WILLIAM MARSHALL.

Of all animals, birds possess the quickest motions, the most energetic respiration, and the warmest blood, and they consequently undergo the most rapid change of substance, and need the most food. Although few creatures are so pleasing to the æsthetic tastes of a poetically inclined person as birds, the breeder knows that most of them are to be looked upon as hearty or excessive eaters. Any one who closely observes birds and their conduct will soon remark that all their thoughts and efforts, aside from the few days they spend in wooing and their short periods of resting, are directed to getting something to eat. With what restless earnestness do titmice plunge through the bushes and the trees! Not a leaf is uninvestigated, every chink in the bark is examined for whatever eatable it may be hiding, and a sharp look is cast into every joint of a branch. How industriously does the ousel turn and thrash the leaves on the ground of the woods all the day long, spying its game with a glance of its sharp eye, and snapping it up on the instant! After observing a few such incidents we can easily believe the stories that are related of the fish-eating powers of the cormorant, and of the fruit-eating birds that are able to consume three times their weight every day.

The result of this property of enormous appetite is an intensified activity in the competition for food among birds, and the structure of their bodies and their habits have undergone considerable modifications in consequence of the fact. It is this which has compelled some birds that should be, according to common poetic conception, creatures of the day, to hunt their prey by night. There are many transitions or connecting links between day-birds and night-birds. Day-birds may sometimes be seen pursuing their prey till late in the twilight; and, on the other hand, night-birds, impelled by hunger, will leave their hiding-places while it is still day. Chimney-swallows are often observed of summer evenings circling around high in the air, in company with the bats. The corn-kite is likewise fond of hunting in the dusk, and is late in retiring to its roost. Several owls do not shrink from the clear light, and the *Strix coquimba* of the Chilian coast hunts only by day. Most evidently the northern snow-owl must do its hunting in the bright glare of the sunlight, else, if it were too par-

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ticular about the matter, it would become very hungry during the long polar day.

The orders of night-birds are not very numerous, and only a few plant-feeders are known among them; but many species are represented among the darkness-loving forms, constituting groups like the owls among the birds of prey and the night-swallows, or in single species, like the strigops and apteryx of New Zealand. In the great family of the waders the stone-curlew, the bittern, the snipe, and others are nocturnal, while the black skimmer and the stormy petrel, among the swimmers, partially exhibit the same peculiarity. Those among these birds which have best adapted themselves to the night-life, however little they may otherwise be related to one another, exhibit a number of peculiarities in bodily structure. The eyes of all of them have undergone some obvious modifications. They are large, capable of considerable widening of the pupil, and otherwise especially differentiated in the elements of the retina. A degree of uniformity also prevails in the disposition of the plumage of all these forms; it is monotonous in its coloring, brownish or greenish gray, but never striking or lively, and this for closely related reasons. First, by means of these dull and therefore protective colors night-birds are enabled to live nearly hidden during the day, and are thereby saved from many disturbances and annoyances; and, secondly, because, in the nature of things, sexual selection, determined by the coloring of the feathers, can not exert any modifying influence upon them. What use has the male night-swallow for beauties which the female can not appreciate? The plumage of the real night-birds is also peculiarly soft and dense, so that their movements in the air are almost perfectly noiseless, and so ghost-like in their silence that they are regarded with superstitious awe by the natives of almost every land.

The food itself of birds is of the most diversified character. While some of the tribe are omnivorous, others appear to be adapted to special kinds of food. Usually forms may be distinguished which feed either exclusively on animal or on vegetable meats, or on both. With most birds the last is, in a greater or less degree, the case. Even the so-called "noble" birds of prey occasionally eat berries and herbs when compelled by necessity. Only a few classes of the animal kingdom, perhaps only those which live entirely in the depths of the sea, fail to contribute of their bodies and lives to the repasts of birds; but vertebrates and insects are their favorite game. One bird will eat only living game which it has caught itself, another only carrion, and a third both. Falcons, eagles, hawks, and owls feed upon living, usually warm-blooded creatures; and, while the presence of these may in some cases be regarded as a calamity, it may in other cases be looked upon as a benefit. Altum, by examination of the hair-balls of indigestible remains of food ejected through the mouth, found that the smaller owls are of the highest advantage in agriculture on account of the prodigious numbers of field-mice they destroy. Yet the farmers kill these benefactors, and nail their skins upon their shed-doors as trophies and admonitions. This is bad enough, even though it be done in ignorance and not in malice. Toads and creeping things are pursued by numerous wild birds—the snake-eagle, the secretary, the curious South American cuckoos called saurothers, and many other feathered foes. The dumb host of fishes finds eager hunters among the birds, even more than among men. Cormorants and pelicans, gulls and sea-swallows, petrels and albatrosses, have made themselves masters of the sea in a higher sense than the most formidable pirate, for the latter is limited to the water, while the birds, not only by swimming and diving snatch the inhabitants of the waters from their own element, but they also capture those fish which, leaving the water for a moment to escape the Scylla of danger from other fishes, throw themselves into the air and into the power of a hungry and greedy Charybdis. And where is any fish in fresh water safe from the pursuit of birds?

No shell or other shelter affords adequate protection to the poor mollusks; but they, too, have to find their way through the maws of birds into the circulating stream of matter. It is true that they usually serve only as a temporary substitute for something else, and few of the inhabitants of the air live exclusively upon them; of these are those curious finches, so like the haw-finch, that live in the Galapagos Islands, descendants from South American castaways, which found no corn-grains on the rocks, but a nutritious though unaccustomed substitute in the shell-fish of the beach, whose shells their tough bills could crack with ease.

The hosts of birds consume immeasurable quantities of insects every day. In no place and no condition are creatures of this class secure from their pursuit. The fat larva, leading a tranquil existence in the depths of decaying wood, is the prey of the sagacious woodpecker. The portly spider, in her dark corner, does not escape the penetrating eye of the redstart. Little beetles and gnats, carried up into the air by ascending currents, are a welcome game to the high-flying swallows.

No more than animals can plants escape the demands of the birds' appetite. Of whatever plants can furnish, excepting only the wood, the birds take their tithes. Humming-birds, besides the nectar, devour the insects that go in after it. The Australian licmetis digs into orchid-roots and lily-bulbs with a bill admirably adapted to that use. The *Polyborus chimango*, of Chiloe, digs up freshly planted potatoes, to the ruin of the farmers, and eats them with relish. Some South American birds feed on aromatic leaves, and the New Zealand night-parrot prefers a delicate liverwort to all other food. But so slight is the nourishing power of this plant that the bird has to consume immense quantities of it, and his crop is swelled out after each meal enormously. Seeds, berries, and fruits furnish a most welcome subsistence to innumerable flocks of birds in all parts of the world. But it makes a great difference to the plant species whether a bird prefers a fruit for its flesh or for its kernel. The yellow thrush and cherry-finch are both fond of cherries—one for the sake of their juicy envelope, the other for the piquant meat of the pits. In the latter case harm comes to the plant ; in the former case good. The colored, fragrant, sweet-tasting berries are there to be eaten, and that principally by birds, while the seeds pass out undigested and with vitality unharmed, but rid of their coverings, which would have to be consumed by decay if not eaten, and thereby, in some cases, even better adapted for planting and growing than before.

The birds in this way contribute much to the distribution of plants. For the appetizing reward which they enjoy, they afford the species, if not the single tree or plant, the most important service ; and when we say that this bird damages the cherries and that one the grapes, we speak from a selfish point of view that which is fundamentally false, for the birds are ultimately useful to the plants. The Smyrneans call the rose-starling the devil's bird when it visits their fruit-trees in July, and forget that they welcomed the same bird as a saint when it cleared away the locusts in May.

Swallowed seeds undergo a superficial change in their passage through the digestive apparatus, which is, however, not detrimental, but rather, like the maceration which the gardener gives to his seeds, only favorable to their vegetation. Acorns which the nut-hatch has macerated in its crop, when dropped, are much surer to grow than those which the forester plants. Some plants are absolutely dependent on birds for their diffusion, and a kind of mutualism exists between the two—one of those remarkable phenomena in which very different kinds of beings are reciprocally advantageous and adapted to one another. A curious example of such adaptation is seen in the case of the mistletoe and the mistle-thrush. The mistletoe, a parasite of trees, is green and evergreen, though few other parasitic plants are so colored ; and the color does not perform the same office to the mistletoe as the green of other plants, for this plant derives its nourishment directly from the sap of the tree on which it is growing without the help of chlorophyl. But it has its uses, one of the chief of which is to attract the thrush to itself. Its fruit-bearing time is when the host-tree has shed its leaves, and it, being all upon the trunk that is green, is conspicuous. Its fruit, a berry, inclosing the seeds in a tough, adhesive envelope, is eagerly sought by the thrush, which can recognize it from a distance by means of the sign it throws out. The seeds hang by their sticky gum to the bird's bill after the fruit has been eaten, and the bird, to remove the nuisance, is obliged to rub its bill against the bark of the tree. This enables the seeds to plant themselves in the crevices of the bark, which afford just the soil they need to sprout and grow in.

Strawberries are a choice delicacy for the wood-hen, and their seeds are minute enough to escape being ground up among the millstones of its crop. The fowls, therefore, unknowingly sow the seeds in the forest along with their dung, and help the plant to find new beds in fresh soil. Geese are especially fond of the leaves of *Potentilla anserina*, and with them eat multitudes of the minute seeds of the plant. Thereby, while the natural home of the *potentilla* is by brooks, it is transplanted by the geese to quite different localities; and in mountain-regions, where nearly all the towns are on little streams, the *potentilla* is to be found as far away in the neighboring fields and along the borders of the woods as the geese are driven in the fall to feed upon the stubble.

When the Spaniards settled in Chili they brought with them their native apple and other fruit-trees. The fruits of these orchards, which were planted, of course, only in the neighborhood of dwellings, were fallen upon by the native parrots, and they carried the apples and undigested seeds into all parts of the country, so that the traveler may now find whole forests of wild apple-trees in places which have received no other touch of human cultivation. In a similar way crows have spread the opuntia over the uninhabited islands of the Canaries, and the nut-crackers in the Alps the seeds of the vetch in places where the winds and man could never have carried them.

Not a few birds are impelled, by the instinct to get their food in as much security as possible, to form relations with other animals. Starlings are found frequently associated with flocks of sheep, making themselves at home on their backs and playing the part of selfish benefactors of the suffering animals as they explore their wool for appetizing ticks and lice. So there are birds, according to eminent travelers, in Africa that perform similar service for elephants, camels, horses, the rhinoceros, and the hippopotamus. These prudent and vigilant birds are ever to be found in company with their huge providences, and give the sleeping monsters timely warning, with their shrill, familiar cries, of approaching danger. Lichtenstein relates that ostriches and zebras are on good terms with one another, to their mutual profit. The droppings of the zebra afford a breeding-ground for innumerable beetle-grubs, and these are a choice delicacy to the ostriches. When any danger approaches the company—if, for instance, a horseman appears in the distance—it is at once perceived by the tall, sharp-eyed birds, which take to flight in a direction away from the threatening object; and the dull-sighted zebras, without knowing what is really going on, sagaciously intrust themselves to the guidance of their careful associates. Similar harmonies in behavior may be observed among animals in very remote quarters of the world—between the rheas and the stags and guanacas of Brazil, and between the royal pheasant and the wild goat of the Caucasus. The ancients had a story of a bird —the trochilus—which made its living by picking the teeth of the crocodile, and in return warned it against its enemies, which has been laughed at as fabulous ; but, in the light of modern observations, there is nothing incredible in it.

Hunger sometimes causes birds to take to the most unaccustomed foods. When sparrows gather around fresh horse-dung and turn it over with evident relish, it is on account of the undecomposed oats it contains ; but there are real coprophagists or dung-eaters among birds. Some vultures, according to Brehm, live chiefly on human excrement, and one of the handsomest gulls of the far North feeds largely on the droppings of seals and walruses.

There are aberrations of taste among birds as well as among men and other animals, the exact origin of which can be definitely traced out. Tame birds—geese, fowls, and doves, the last of which in particular are strict vegetarians—can, by the withdrawal of their accustomed grain, be won over to the enjoyment of animal diet till they prefer it, and may finally have their new taste so highly cultivated that they will spurn vegetable food. These changes do not mean much when they are compulsory ; but they become very significant when they are wholly voluntary. Our common sparrow has within a few years gained legal, scientific, and even political fame by reason of its change of food-habit ; and, amid all the controversy that has raged about its character, it is clear that it has become extremely ravenous and destructive to broods of young song-birds. Yet the sparrow is originally an eater of animal food, living on larvæ, worms, and snails, from which the step is not so very great to the devouring of a little wee, helpless chick ; but the perversion of taste which the New Zealand kea (*Nester productus*) has undergone is of a different character. The nature of its home as well as its organization made it clearly a vegetable feeder, and there was no apparent occasion in its normal state for a bloodthirsty taste or a predatory inclination to arise within it. With the introduction of sheep-raising in New Zealand the bird's nature seems to have been changed. It learned to feast upon the blood of the slaughtered animals, and, having once tasted blood, it conceived such a relish for it that it was no longer able to satisfy its appetite with the occasional slaughter of a sheep, but began itself to take the initiative by falling upon animals which were suffering from slight wounds and opening the sores to make the blood flow. From this it advanced till it learned to help on the accident and make wounds for itself.

Birds living naturally on flesh are sometimes turned, without any stress of necessity, to become vegetarians. A considerable number of insect-feeders in Southern Europe eat fruits, especially figs, with evident relish, and the habit abides with them not only there, but also in other regions when they pass through them. I once became very indignant in Corfu at seeing an old, lank fellow, with a fowling-piece likewise old and lank, shooting the little singing-birds, among which

I recognized my particular favorite, with unerring aim. On my remonstrating with him, he said they were fig-peckers and destroyed the fruit. I laughed at him, and, to convince him that he was wrong, took out my pocket-knife and cut open one of the dead birds. It was his turn to laugh, for the maw of the bird was distended to the full with the soft, seedy fig-pulp! The green woodpecker, whose whole structure should make it a first-class insect-eater, is very fond of service-berries, and is, according to Pallas, destructive to the grapes around Astrakhan. Another woodpecker is fond of hazel nuts, and has learned how to crack them; but it may be that it was first introduced to this sort of food by exploring the nuts for worms. In fact, there is great room for the development of individual tastes in birds. But there are limitations in the matter, and the maxim "What is one man's meat is another's poison" applies well in this case. House-doves can eat beans without harm, but geese after partaking of them sicken and sometimes die. The cause of the difference is mechanical. The doves grind up the beans in their crop, while the geese have to digest them, and are sickened or killed by the swelling they undergo in the process. A real physiological puzzle is presented, however, in the case of some chemically acting poisons which a few animals, including some birds, can partake of with impunity, while they are deadly to all other creatures.

The birds' work is not always done when they have captured their food. Sometimes they have to prepare it to a certain extent. Many of the smaller birds of prey pluck their game before eating it. Others wash their meat, as I once saw a stork do; and while this queer bird would swallow frogs without any ceremony, it gave the mice that were thrown to it a thorough soaking, probably because their hairiness interfered with the comfortable swallowing of them. A sagacious canary-bird I once knew had learned the art of soaking in its drinking-vessel the crumbs that were too hard for its bill to break up. Shell-fish give birds much trouble, but the heron proves itself a match for them by swallowing them whole, shells and all, and keeping them in its maw till the animals are killed by the pressing in of the digestive fluids, and the shells open; then it spits them up and feasts upon the soft parts. Crows carry them up into the air and drop them upon stones, whereby the shells are broken up. The lammergeyer, according to Krüger's observations, does the same with marrow-bones and turtles; and it is possible that the eagle that killed Thales by dropping a tortoise upon him, mistook the shiny skull of the philosopher for a big, extra hard stone!

Storing up of food is quite a common practice in the bird-world. A European species of nut-hatch collects hazel-nuts when they are abundant, and hides them in the hollows of trees; and the snow-hen of Greenland does something of the same kind. The pine nut-cracker collects vetches, and the common nut-hatch, which appears frivolous enough in its every-day life, acorns. One of the most remarkable instances of avian providence is that related by Saussure, of the Mexican *Colaptes.* The sides of the extinct crater of Pizarro, in Mexico, are covered during the winter months with the dried-up hollow stalks of the last year's agave-flowers, over which a yucca-tree here and there casts a scanty shadow. Hither, at the time of the ripening of the acorns, come large flocks of the birds with acorns, which they have brought from a great distance, for no oak-tree grows within many miles of the spot. Beginning at the bottom, they bore with their deft bills a succession of holes, at short distances apart, in the hollow agave-stems, and through them deposit their acorns in the interior cavity. The acorns look, when the magazine is filled, laid one after another, like the beads of a rosary. When the time of scarcity arrives, these insect-eating birds hasten to their store-houses, extract the acorns from them, fly with them to the yucca-trees, and, boring in the bark of them holes large enough to hold the acorn, as an egg-cup holds an egg, break open the fruit and eat it in comfort. Saussure avers that the acorns in question are sound, and free from worms.

Other birds, not looking so far into the future, provide only for temporary wants. A species of owl, according to Naumann, feeling the approach of a storm, lay up a stock of mice to last them through the nights when they will be unable to hunt. When the red-backed shrike has caught more than its appetite demands, it spits the surplus —young birds, frogs, and larvæ—on thorns; whence it has been called the thorn-turner, or, because the people believe that the number of its victims is always nine, the nine-killer. Curiously enough, a relative of this shrike, the *Collurio Smithii*, of Africa, employs, to accomplish a similar object, the more difficult method of slipping one end of a plant-fiber around the victim's neck, and hanging it by the other end to a bush, thereby giving its store-room a kind of resemblance to a gallows-yard. Not only are these lesser special peculiarities, these side-features of the bird's habits, as we might call them, determined by the kind of food and the method that has to be employed to obtain it, but more important and fundamental features of its life, its migrations, its distribution, and many of the motives of its propagation-history, can be traced back to them. The origin of the migratory instinct has usually been sought in climatic causes, and in the desire to avoid the cold and hardships of northern winters. This is an error. The little titmice and modest wrens, which are able to find the most carefully hidden larva in its winter-quarters, and can discover the most minute insect-egg, and which will not disdain a berry or a seed, stay with us through ice and snow; but the larger and stronger cuckoo remains in the north only while insect-life is at its height, and starts early on its southward journey. The great shrike is a permanent resident in Europe, going away only rarely, in case of dire extremity, but its three indigenous relatives are real birds of passage, appearing in May and leaving again in August. The former bird is large and strong enough to capture other grown birds and mice, and can thus always find a bounteous table spread for itself, while the others, confined by their more limited powers to smaller creatures, have to go away when, with the end of summer, these fail. The carrion-crow, to which everything that it is only possible to swallow furnishes a delicious feast, is not troubled by the severity of winter; but the rook, whose bill of fare is more limited, is in no condition to endure the scarcity of the winter months, and, therefore, on the approach of fall, it flies in large flocks over the Alps and Pyrenees, to the luxuriant fields of Southern Europe and Africa.

While this brief glance at the connection between the yearly migrations of birds and their food-supply must suffice for that point, the consideration of the distribution and accidental wanderings of these remarkable creatures, so far as it is related to their commissariat, demands more attention. It is evident that an animal species can live and thrive only when its accustomed provision, or some substitute similar in character to it, is present; where this is wanting, it can not gain a permanent footing; or it must adapt itself to its new relations, undergo gradual modifications in its habits and organization, and thus in the course of time become another and new variety. But wherever it can find its accustomed subsistence in the usual quantity and season, it will readily make itself at home without having to undergo any modification, unless it is provoked by other causes. If we ask what creatures—what birds, in the present case—have under particular circumstances the greatest chance for a wide distribution, the answer will be that they are those which, like the crow, the thrush, and the true shrike, are least particular in the choice of what they eat; and next, those whose appropriate food is most widely diffused. But the more closely a bird is adapted to particular kinds of food, and the more limited the circle of its distribution, the narrower will be the field of its residence. This is the case, not only with species, but in a wider sense with genera and families, and it is not to be overlooked that very widely distributed species are also frequently permanent residents. The most uniformly distributed animals under all conditions of climate and season are vertebrates, especially fishes and the smaller land-mammalia, and also some insects; and they also exhibit less important and diversified variations, and demand less on the part of their pursuers, than insects. Next to these are certain invertebrates of fresh and salt water; and among these the shore-species, particularly within their seasonal limits, display a great uniformity in all parts of the earth. Birds of prey, except the carrion-eaters, live on land-vertebrates. Three of their four families include quite or nearly cosmopolitan genera, and, what is rare among land-birds, only three species are wanting in very small districts. Fish and water animals constitute, with few exceptions, the food of the large groups known as the waders and swimmers. Of the fourteen families of the former groups, four are quite and one nearly cosmopolitan; and of the eight families of the latter group, among which are some powerful fliers, only three have not a universal diffusion; and the two groups exhibit more genera occurring over nearly the whole earth (eighteen out of ninety-six and eleven out of seventy-nine) than all the other families of birds put together. But we can not overlook the fact that some of these genera stand on a very feeble footing.

It is interesting to observe that, in the other orders of birds, those kinds that live on fish are very widely spread. Thus, the kingfishers are cosmopolitan, and the genus *Ceryle*, which Brehm says includes "the strongest, most active, and most ravenous members of the family," is especially wide-spread, and is without representatives only in Australia, Madagascar, Europe, and Northern Asia. The nine not greatly differing species of water-ousel, whose habits are much like those of the true kingfishers, are very widely diffused wherever there are cool, clear, and rapid mountain-brooks.

The distribution is less wide of such birds as live principally on land-invertebrates, especially on articulates. Their occurrence is largely dependent, like that of plant-feeders, indirectly but intimately on the character of the vegetation; and those forms among them which, like titmice, wrens, and woodpeckers, live on insects at rest, as well as on eggs and pupæ, or on larvæ, either concealed or living in wood, and changing place but little, have the most extensive range; and, since larvæ pass the winter in one of the forms mentioned, they are permanent residents in temperate climates. In the measure that a bird pursues perfect insects, particularly those which fly, it becomes possible for it to be an established inhabitant only in warm climates. To dwell in colder regions, if it usually refuses vegetable food, it must be a good flier, and is then compelled to go away on the approach of the cold season and the accompanying disappearance of its food.

The presence of plant-eating birds is still more predominantly dependent on their food; and it is a matter of interest to observe how the opening out of the vegetation of a country reacts upon its ornithic population. Africa, wherever it is not wooded or desert, the Europeo-Asiatic steppes, and the prairies of America, are covered with grass and other mealy-seeded herbs, and are also the dwelling-places of hosts of weaver-birds, larks, and other grain-eaters, the flocks of whose numerous species are numbered by the thousand; and wherever they can find their food in winter, they abide. Groups of berry-bearing plants cover extensive regions of the north, and follow, as they stretch down toward the south, the cooler regions of the higher mountains; and in their suite we find everywhere, in the tundras of Siberia, on the slopes of the Himalayas, and in the Peruvian Andes, fruit-eating birds of similar genera. In the fruit-rich woods of the tropics, especially of South America, more than half of the native birds, though representing very different families, live chiefly, and for the most part exclusively, on the fruits; a thing that would not be possible in a temperate climate, where the development of the fruits is limited to a small part of the year. The immense northern pine-woods of the Old and New Worlds have their denizens from the bird-world living exclusively upon their seeds in the cross-bills, which are quite as much tree-birds as the tropical parrots.

The abundance of grains, fruits, insects, and even of mammalia, such as mice, is, on account of the varying local weather conditions on which they are dependent, much more variable in temperate than in tropical regions. One year may be rich in these products, and the next very poor; unusually favorable conditions for their growth may prevail for the time in one locality of an extensive territory, while in neighboring districts, from causes which it is often hard to explain, the contrary may be the case. Such circumstances must, of course, act with great effect upon the bird-world. At some times the birds of a region may, on account of the failure of their principal food and consequent famine, be driven from their hereditary quarters, and compelled, becoming wanderers, to resort to districts that are strange to them. When the pine-nuts fail in the north and on the mountains, the nut-crackers that feed upon them, obeying necessity, and not doing according to their custom, come south; and, when it is a bad year for birch-seed, multitudes of the northern linnets visit Europe. During long, snow-bound winters these northern and northeastern birds may be seen abundantly in Germany, and away down in Southwestern Europe, and the superstitious countrymen see in the unusual visitors the heralds of coming disasters.

On the other hand, an unusual abundance of food attracts birds into places to which they are not accustomed, and leads them into strange companies. Naumann relates that the thistles once got so firm a hold in the pasture-lands near his home that in many places the previously luxuriant grass wholly disappeared; then there came great flocks of green-finches, attracted by the abundance of their favorite food, and more in the next year at the time of the ripening of the seed, till, in a few years, all the thistles were exterminated through the agency of these birds. In another place he tells of a pine-woods of only thirty acres, to which hundreds of cuckoos resorted, attracted by the enormous number of caterpillars. It has also been frequently observed that horned owls are to be found by the thousand in localities that are plagued by an unusual visitation of mice.

Numerous birds attach themselves to droves of wandering animals. The passage-falcon travels regularly with the birds of passage; schools of herring are accompanied by throngs of fish-eaters, especially by the gannet, the presence of which is regarded by fishermen as the surest indication of the neighborhood of herring. So, swarms of locusts, pressing toward the West, are attended by birds to which they are food, usually peculiar to the East; lemmings, by the snow-owl; and in former wars of great severity, the armies by wolves, hawks, and ravens; and I have been told by eye-witnesses that the relics of the Grand Army were pursued in their disastrous retreat from Russia by thousands of ravens. Many birds owe their specific diffusion to their seeking out men, the products of their civilization, or their domestic animals, to live upon them; and many formerly strange species no doubt find their way into new countries after the introduction of grain and fruit-raising.

The relation of subsistence to the propagation of birds is of the highest importance; upon it largely depend the time of breeding and the number of the eggs and of the brood. We are accustomed, without sufficient grounds, to assign the reason of our putting fowls to sit in the spring, as well as the migrations of birds, directly to climatic influences. We speak of the awakening of Nature, and it seems self-evident to us that the bird's nest with its tender chicks is a necessary part of it. Yet the time of year has hardly anything to do immediately with the propagation of birds, which is rather determined by the presence of a sufficiency of proper food.

In warm countries, such as Egypt, Ceylon, or Brazil, birds hardly observe a fixed period in their nesting, but each pair sets about the business whenever it finds itself in the most favorable conditions of subsistence, so that we can find nests and eggs of the same species in every month. The *Falco eleonoræ* of Southern Greece breeds at the unusual season (for a bird of prey) of August, and has its young in September. Quails are plentiful in the country at that season, having come down fat from the north, and in their multitude and helplessness fall a ready prey to the young falcons, and a much richer support than the birds can find in the spring, when, according to Erhardt's observations, no quails are ever taken in Greece. The *Bombicilia Carolinensis* of North America breeds as far north as 40° in June; it feeds its young on berries and cherries. The cross-bill never asks about the season or the temperature. It fixes its household indifferently in winter amid ice and snow, and in the height of summer, provided only sufficient nourishment for its children is present. The barn-owl likewise breeds irregularly. Its eggs and young have been found in October and November, but always in those years and places in which field-mice are unusually prevalent.

These few examples may suffice to show how, with birds, nearly everything turns upon subsistence; how the fact holds good not only for individuals and species, but that it is a matter of fundamental importance in their structure, their spread, and their habits, and how we may, with perfect right, apply to birds the maxim, "Tell me what you eat, and I will tell you who you are."—*Translated for the Popular Science Monthly from "Unsere Zeit."*

HIGHER EDUCATION OF WOMEN AND THE FAMILY.

BY LUCY M. HALL, M. D.,

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THE address of Dr. Withers Moore, President of the British Medical Association, delivered before a general meeting of that body, August 10, 1886, has attracted very wide attention. The importance of the subject with which the paper deals can not be overestimated. A few quotations will best show what it is and what are the views of the author upon it:

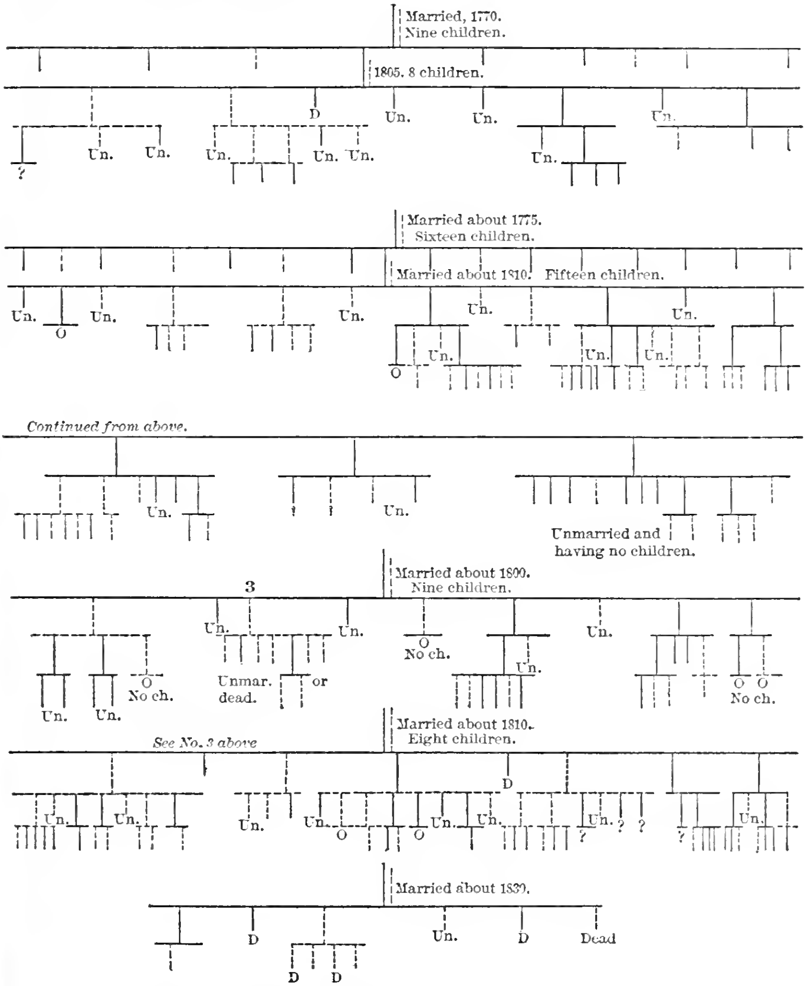
"Education is very expensive, physiologically as well as pecuniarily, and growing girls are not rich enough to bear the expense of *being trained for motherhood*" (the *italics* are my own), "and also that of being trained for competition with men in the severer exercises of the intellect. Woman should be protected from the rude battle of life by the work and labor of man. . . . It is not good for the human race that women should be freed from the restraints which law and custom have imposed upon them, and should receive an education intended to prepare them for the exercise of brain-power in competition with men. . . . Bacon, for want of a mother, will not be born. She who should have been his mother will, perhaps, be a distinguished collegian," etc.

The report goes on to say that "Dr. N. S. Davis, of Chicago, cordially sympathizes with these sentiments, and said that in America they had abundant evidence of their truth." And a late number of "Science" adds: "There are two channels of expenditure of physiological force in woman—the *terrible strain* of higher and professional education, . . . and the expense of being properly trained for motherhood."

Surely no one would be more ready than I to accept the conclusions of Dr. Moore and his supporters could I but be convinced that they have been drawn from reliable data, and presented in an unprejudiced manner.

It is true beyond question that in America the small and rapidly diminishing numbers in the family is a matter of grave national import. Dr. Nathan Allen has written much upon this subject, especially in connection with the New England States, but the difference in this regard between those States and other localities where the families are purely American is very slight. Presuming that physical laws operate much in the same manner upon both sides the Atlantic, we shall confine our discussion to American soil, and thus endeavor to find just what basis we have for accepting the theories which have been forced upon our notice, to discover in what the "abundant evidence" of Dr. Davis lies; or, failing in this, to seek for the kernel of truth in some other direction.

A short time ago I began collecting facts intending to show the great falling off in numbers in the American family, taken without regard to location or worldly circumstances. These I will now present (although they are as yet quite incomplete), because they have a direct bearing upon the subject which we are considering. In some of the tables only one or two lines of descendants could be traced; in others, all or nearly all appear:



Un., unmarried. Dotted line, females. Plain line, males. D, dead. No ch., no children.

Nearly all grades of American life have been included here, excepting perhaps that found in extreme poverty. The women were, for the most part, simply educated. Some in the district school only, while others were instructed with due deference to the limitations considered proper in female education, and with the usual surfeit of "accomplishments." A few were more highly educated, and yet as large a proportion of the latter as of the former have married, and the *largest families of the present generation belong to the most highly educated of the women.*

Within a stone's-throw of where I sit are half a dozen well-to-do American families. Taken together, there are not as many children in them as there are parents, and in none of them will there presumably be any increase. Not one of these mothers is in any sense a highly educated woman.

In one hundred and seventy-five American families I find an average of 3·2 children (now adults in most cases) to each. In one sixth of them there is but one child each. (No childless families are included.) Of the few really large families, the evidence seems to be that the mothers were in most cases well educated ; in a few cases, exceptionally so. Taken as a whole, they represent a very wide range of female education, from the most ordinary to the highest which the time afforded. I have made many inquiries as to the proportion of children in American and foreign families in the schools of Brooklyn and New York, and I find that in the German, Irish, and Italian families there are two, three, and four times as many children, upon an average, as there are in the American family.

It would be difficult for even the most prejudiced observer to attribute these maternal deficiencies to the "higher education of women"; and it is a little singular that we are so often treated to a bald statement of the "higher-education" theory, without any facts being adduced by which to prove it. The diminishing and vanishing native family is a fact, but a fact which must be accounted for in some other way than the one proposed.

In turning elsewhere for an explanation, we will leave out of our present discussion those men—and their name is legion—who have brought to their wedded lives only the remnant of a vitiated or shattered constitution, or those in whom the instinct of fatherhood seems to be so nearly wanting, that they are not willing to make any of the sacrifices incident to the rearing of a family ; and will consider the question solely from conditions which obtain with the other sex.

Here the two great primary causes are—1. Physical disability. 2. Disinclination to bear and rear children. We will briefly consider these in their order, though their order could well be reversed if in that lay any indication of their relative importance.

There is something almost ludicrous in the spectacle of a physician, educated and professedly observing, passing over without a word all the death-dealing follies which are making invalids of tens of thousands of women all about him, while he lifts his voice in dismal croaking over the awful prospect which looms before his jaundiced vision, of a time when more women shall be educated. Forgetting all else, he might have spared one thought for that doomed multitude, shut off forever from honorable motherhood, gone to dire destruction, because untrained in anything which would insure to them a self-respecting independence.

Just what is meant by the term "being trained for motherhood," or why this training should be designated as "one of the two great channels of expenditure of physiological force," I find myself unable to understand. But it may safely be asserted that *any* training which exhausts without more than correspondingly strengthening a part, no matter where applied or for what purpose, should straightway be condemned. The "competition" and the "terrible strain" theories seem to me to have but little foundation. In my university life I saw nothing to confirm them. The work was pleasant and inspiring, and I am sure I can safely say that for the most part we enjoyed it. We did not trouble ourselves about the relative weight of our brains, and, as in the district school or the high-school, so here, it mattered little whether it was Jane or John who stood best; and it was quite as likely to be Jane as John.

As I recall the animated faces, the healthy bloom, and high spirits of the young women, I fail to find any ground for the assumption that their work was in any sense done at the expense of their vitality. On the contrary, I know that in many cases there was decided improvement in health from the beginning to the end of the course.

All this much-talked-of "physiological expenditure" is a myth. The intellect is quickened and strengthened by proper use, not at the expense of any other organ, but in and of itself. It is with this as with the muscles: strength comes with use. The fault has lain, not in the training of one set of organs, but in the neglect of others. The balance of health has thus been lost, and all parts have suffered in unison. To correct this, to establish a harmonious development of mind and body, is what true higher education aims to accomplish; and in doing this it is striking at the very root of woman's disabilities.

Seeing daily, as I do, young women in college in far better health than young women in society, or living in pampered idleness at home; seeing them healthier as seniors than they were as freshmen; knowing that my records tell me that they average a smaller number of excuses because of illness than do those of the men's colleges with which I am able to compare data, and knowing from statistical evidence that woman college graduates enjoy a sum total of twenty per cent better health than the average woman, how can I conclude otherwise than that college-work, *per se*, is not injurious to health, nor incompatible with the best good of the sex and the race? *

* President Bascom, of the University of Wisconsin, says on the same point: "The young women do not seem to deteriorate with us in health, but quite the opposite. . . . It has long seemed to me plain that a young woman who withdraws herself from society and gives herself judiciously to a college course is far better circumstanced in reference to health than the great majority of her sex.

Where is there a physician who does not know of countless numbers of women among the wealthier classes who are beset by all manner of ailments, for no other reason than because they have nothing to do, or rather because they have brought nothing into their lives which called forth the strong motive forces of their natures? The petty, selfish considerations which have dominated them have been too shallow to float them out into the broader channels, and they have become poor, stranded wrecks, with no interests but their aches and pains, no comfort but in the doctor's daily visit. The contemplation of these wasted lives, powers for good gone to rust and decay for lack of use, should make the angels weep. God forgive the man or woman who would wish to keep alive the baleful thrall of old prejudices and customs which work such irremediable evil to the human race! John Stuart Mill has said that "there is nothing after disease, indigence, and guilt so fatal to the pleasurable enjoyment of life as the want of a worthy outlet for the active faculties." He might have added that nothing so tends to promote disease and physical poverty as such a want.

Of the barbarous inflictions of fashion, of the effects of social dissipation upon the impressionable nervous system of a young girl, of the neglect of such exercise as is necessary to her vigorous health, I have no time to speak more fully, but among these are found some of the greatest hindrances to health, some of the most serious obstacles to motherhood.

One of the greatest of living physicians, Sir Spencer Wells, says: "As for the outcry against women taking up mens' work, it is breath wasted. For my own part, I think women capable of a great deal more than they have been accustomed to do in times past. If overwork sometimes leads to disease, it is morally more wholesome to work into it than to lounge into it, and if some medical practitioners have observed cases where mental overstrain has led to disease, I can not deny that I also have *at long intervals* seen some such cases. But for every such example I feel sure that I have seen at least twenty where evils equally to be deplored are caused in young women by want of mental occupation, by deficient exercise, too luxurious living, and too much amusement."

That a strong disinclination to bear children is manifested by many American women no one can deny, and the rich even more than the poor seem averse to giving themselves to the cares and deprivations incident to the rearing of a family. These women are ready and willing to marry, but they have no intention of burdening themselves with the laudable results of matrimony.

Women with one or two children, wealthy, living in palatial residences, will tell you that they can not *afford* to have more children; also that they are quite worn out with their present cares, and that to have a large family would *break them down completely;* so by their manifold arts, all tending to thwart the Divine laws of their being, coupled with the selfishness and inanity of their lives, they succeed in bringing themselves to a state of physical disability which one of our prolific great-grandmothers would have been horrified to behold!

The root of the whole matter lies in the purposeless drift of everything which has been wont to enter into a woman's training. She has been made to feel that "woman should be protected from the rude battle of life by the work and labor of man," and these women have boiled down the sentiment into a selfish disregard of every obligation which they owe to the world. They most decidedly approve of all the limitations to "woman's sphere." They marry because they want to be taken care of, and their estimate of the value of life lies in the getting of the greatest amount of creature comfort with the least possible personal outlay; so "Bacon, for want of a mother, is not born." Not, however, because "the woman who should have been his mother is a distinguished collegian," but because she will have none of him; and his unwelcome existence is cut short long before it is time for him to appear upon this mundane sphere.

The poor woman has the same aversion to having a family that the rich one has, and for much the same reasons. Trouble and expense are to be avoided, and, worse than all, it is unfashionable to have a large family. I well remember hearing in my childhood a healthy young married woman held up to ridicule because she had so many children. Strange to say, her husband was commiserated in the same breath as a much-afflicted individual! At length, in an evil hour, the poor wife listened to an evil counselor, and the handsome, rosy-cheeked woman was from that time only a sallow, sad-eyed wreck of her former self. But she was no longer a target for the idle jests of her neighbors; the cradle was empty, and ever after remained so.

This is the kind of sentiment which openly or covertly prevails with us, and this is the Moloch to which are being sacrificed not only the health of so many of our women, but the lives of unborn millions who should stand crowned the sons and daughters of our glorious land.

It is in the higher, broader education of women that our hope for the future lies. The alarmists who cry that women will not marry if educated know full well that they are firing blank cartridges into empty space. There will always be plenty of women with brains and plenty also without brains from whom to choose, so that no man need go without a wife. If he prefers one who has a knowledge of Greek verbs stowed away somewhere in the neighborhood of an adorable pair of eyes, so much the better for him, for no amount of education will ever prevent a woman from marrying the man of her heart when he appears; and her education will be the best surety of her marriage resulting in all that which a true marriage should bring.

I do not mean to say that every girl should have a college education. What I do mean is, that the colleges are becoming centers for the training of girls to more healthful ways of living, both mental and physical; and the only thing to do for women of the wealthier classes to lift them out of the ruts of idleness and destructive obedience to fashion's vagaries is to educate them, and give them broader interests and a mental grasp of the value of life because of its obligations to other lives.

Men and women must ever be one in every interest which affects the public good. It is difficult to see how even individual welfare can be made distinct. Women with low ideals, selfish, and untrained; women with feeble, undeveloped physiques, as well as women whose high moral and intellectual worth is enhanced by bodily perfections, all have an influence that puts its stamp upon the household of which each forms a part. And to "train a girl for motherhood" can be done in no better way than by building her from day to day upon the noblest plan which the grand and growing facilities of our time have made possible to us.

THE HABITS AND FAMILY HISTORY OF CENTENARIANS.

By Professor HUMPHRY, F. R. S.

THOUGH it must be granted even of the centenarian, as of all others, that he soon "passeth away and is gone," yet happily we are not obliged to admit that his "strength is but labor and sorrow." In many instances, on the contrary, he has, if not a green, yet a mellow and cheerful old age, one of happiness to himself and pleasure to others, brightened by a vivid though calm interest in the present, and unshadowed by apprehension of that which is to come. "Pay me a visit when you next come to Leamington," were usually among the words of adieu by Miss Hastings, at the age of one hundred and three, to her friends; "I shall like to see you, and hear how you are going on." There is a great moral in this; for while we are denizens in this Mammon, we are bound to make to ourselves friends of it, which is best done by a cheerful, happy use of it, and by enjoying it and using well the powers and privileges it gives us; and the injunction is none the less imperative and valuable when the sojourn in it has lasted for five score years and more. Moreover, in this, as in so many other instances, the influences are reciprocal; for associated as cheerfulness and happiness are with good doing and kind feeling, they are also much dependent upon the smooth working of the several parts of a sound bodily machinery, to the heathfulness of which they in their turn not a little contribute. So long, indeed, as the body is enjoyable, and its functions go glibly and smoothly on, the tenant is commonly desirous of continuing its occupation. When it ceases to be so, when lassitude and weariness supervene, when means of communication with others are stopping, when the "*sans* everything" condition is impending, he is content to quit; and, when the tenement becomes distressing or painful, he is anxious to do so. Still, though the capacities for activity and work may be passing away, and life's "fretful fever" with them, the old person may comfort himself with the reflection that a useful mission still remains in the benign influence of a serene and benevolent disposition, which calmly estimates the things of time and sense at their true value, and which, leniently regarding the short-comings of others, gives the true crown of glory to the hoary head.

It is most satisfactory to find that the exercise—even the full exercise—of the various powers, mental and bodily, is not merely compatible with, but is conducive to, great age; that, as has been well said, "the harmonious development of the many-sided aspects of man is conducive to health and the prolongation of life," and that there need be no fear of entering heartily and actively, and with full interest and energy, into the assigned work of life, physical or mental. The body is made, not for ease and sloth, but for labor and play, for work and enjoyment, better still for enjoyment of work. Work, enjoyed as it should be, promotes health in body, and especially if stimulated by other motives than personal ambition and gain, engenders that cheerful, placid frame of mind which is one of the adjuncts of centenarianism.

France has lately celebrated the centenary of a philosopher and a chemist, M. Chevreul, who the same night occupied the President's box at the opera; and we are told that a Chinese centenarian recently passed the examination which qualified him to enter the highest academy of the Mandarins. Delightful was the account of Lady Smith, in whom a bright, intelligent mind and a brisk, healthy body had been in uninterrupted harmonious action for a hundred and three years, and who to the last took a lively interest in the world's political and other movements.*

* The original report of the committee of the British Medical Association, of which these observations by Professor Humphry are a part, was accompanied by a series of elaborate tables, in which all the details here summarized in the paper were given separately for each person. As the results and lessons of the investigation are clearly presented by Professor Humphry, in all their important bearings, with estimations of the value of each of them, we omit the tables, which, however useful they may be for reference, are not pleasant reading. In introducing the table the author remarks that in "their publication it is not meant to be implied that each of the fifty-two persons positively attained to the age of one hundred years. Some, no doubt, did so; and in eleven (two males and nine females) the age was confirmed by baptismal certificates or other records. Respecting others, there is necessarily more or less uncertainty; but these may reasonably be assumed to have reached nearly to that age. The name is given in each case; and the names are also given of the informants. These were nearly all medical men who volunteered the information which they would not have done unless they believed it to be correct, and who, in many cases, were well acquainted with the persons respecting whom they gave the particulars. The well-known pride of longevity and the tendency to ex-

Among the centenarians on our own list, the intellect is stated to have been high in eleven and low in five only; twenty are reported as strong, sixteen of average strength, and twelve only as feeble. Several were remarkable for mental and bodily activity and energy during their long lives. Many had been engaged in hardy bodily toil, or mental work, or successfully, in various occupations, and, in different ways, had played their parts effectually on the world's stage to the end of the long drama in better plight than the poet has represented them. I often wish Shakespeare had lived to give a brighter version of his seven stages, and to portray the old man not lean and slippered, but well favored and booted, keen in life's interests, and happy in promoting the welfare and enjoyment of others. Even in the bedridden state, of which the tables give seven examples (four males and three females), one of whom had been bedridden for seven years, all is not cheerless. The quiet coziness, the even temperature, the freedom from exposure, and the reservation to the vital organs of nerve-energy and nutritive material, consequent on the diminished use of the muscular system contribute to prolong the lives of some feeble persons who still retain the pleasures of intellectual occupation and social intercourse, to say nothing of the enjoyment of sleep and the gratification of the appetite; and it is curious, though not unfrequently to be observed, that persistence in bed actually increases both sleep and appetite. Some aged people lie in bed in the winter; and, in the dull routine of the workhouse, many old people drift into the bedridden state.

In our tables, as usual, in records of longevity, the women preponderate over the men (thirty-six to sixteen), in spite of the dangers incidental to child-bearing and the diseases associated with the varying demands made, at different periods, upon the organs connected with that process. This is obviously, in great measure, to be attributed to the comparative immunity of the woman from the exposures and risks to which man is subjected, as well as to her greater temperance in eating and drinking, and her greater freedom from the anxieties attendant upon the world's labor and business. Still, as I have said in a former essay ("British Medical Journal," May 9, 1885, page 928), there appears also to be a greater inherent vitality in the female, as evinced by the fact that, even in the first year of life, when the conditions and exposures of male and female infants are the same, the mortality of girls is less than that of boys. A somewhat larger number of boys are born, but they are more difficult to rear, so that the females

aggerate and deal with the marvelous, throw some suspicion over all records of this kind, and indeed had well-nigh caused a revulsion to misbelief in the capacity of the human body to retain vitality for so long a period as a hundred years. Abundant well-established examples of its doing so have, however, dissipated that skepticism which, I suppose, is now held by scarcely any one. It will be observed that none of the cases here tabled range among the marvelous and startling instances we sometimes read of; not one is stated to have reached one hundred and ten; one only is said to have been one hundred and eight and one one hundred and six.

soon take the numerical lead, and they maintain it with almost steadily increasing ratio to the end. It is also to be learned from the analysis of the tables that the elasticity of the thorax, as evinced by the condition of the costal cartilages, and its capacity for dilatation during inspiration, is better preserved in women than in men. In the matter of the arcus senilis, also, the woman has the advantage ; but in the condition of the arterial system, much difference is not shown.

Of the 36 women, 26 had been married, and 11 had large families ; and it may be some consolation to young mothers and their friends to find that 8 of the 26 married before they were twenty—1 at sixteen and 2 at seventeen. The dangers, happily diminishing, which are incidental to child-bearing, must not be forgotten ; but, irrespective of these, the process itself and the attendants thereon do not seem to militate against longevity. Indeed, the capacity for the full exercise of this, like that of the other normal functions, is one of the qualities in those who have the other requisites for attaining to great age. One only of the married women was childless ; but neither the age at which she was married nor the duration of her married life are given.

It might be anticipated, indeed, from the matrimonial tendency, and the prolific quality evinced by the tables, the average number of children born to each, whether male or female, being 6, that there would be, through inheritance, a gradual increase in the centenarian breed ; and it is probable that this is the case, and that the duration of life is, from this and other favoring causes, gradually being extended. The life-period of the children we have no means of determining with accuracy, the returns being, from various causes, imperfect ; but we may safely accredit them with, at least, an average longevity. It is, moreover, a point of some interest that many of the centenarians were members of large families, averaging, indeed, 7 or 8 ; those designated as "only children" being limited to 2. Of the 52, 41 had been married, and 11, of whom 10 were women, had remained single ; but we can not from this draw any inference as to influence of matrimony upon longevity. Possibly something may be gleaned from the analysis of the numerous reports I have received of persons between eighty and one hundred.

The fact that 12 of the centenarians were "first children" does not accord with the idea entertained by some persons that first children are at a physical disadvantage. The generally prevalent custom of inheritance by the first-born, and the Mosaic injunction (Exodus xii, 2), "Sanctify unto me all the first-born ; whatsoever opened the womb among the children of Israel, both of man and of beast, it is mine," are also scarcely in harmony with such a view. Nevertheless, some confirmation of the view is furnished by the feeling on this matter, founded, it may be presumed, on experience in racing-stables, which, I have been informed, is not in favor of firstlings. In the case of one of our centenarians, the parents were first cousins.

The tables and the analyses of present and past condition yield nothing striking or even novel or unexpected, or in that respect interesting; but they are not therefore less valuable or important. The average centenarian qualities are precisely those which might have been anticipated: a good family history; a well-made frame of average stature (5 feet 8 inches, which is rather above the average, in the male, 5 feet 3 inches in the female); spare rather than stout, robust, with good health, little troubled with ailments of any kind, with good digestion, regular daily action of bowels; active, capable of much exertion, with the restorative advantages of good, sound sleep permitting or inducing early rising; good vocal organs; a good appetite moderately indulged, with little need of, and little consumption of, alcohol or animal food; an energetic yet placid temperament; a good intelligence; the hair holding its ground and its color well; the organs of sight and hearing performing their functions well and long. Our centenarians afford, in short, good examples through life of the *mens sana in corpora sano;* and in by far the greater number there was a total absence of any evidence of rheumatic or gouty affection, past or present, in the joints of the hands and fingers—a condition which is not unfrequently regarded as one of the heralds of old age, and which, doubtless, like many other local maladies of which it may be taken as a sample, is often prophylactic against other more serious maladies. It seems that the frame which is destined for great age needs no such prophylactics, and engenders none of the peccant humors for which the finger-joints may find a vent. To have a vent for such humors may be good, but it is less good than to be without them. Of the eight in whom those joints were stiff or deformed, it may be observed that one, a man, always "drank as much as I could, and always will do"; a second and third, poor women, had been subject to much exposure, and had a rough life, following the army in various parts of the world; of the case of the fourth, also a female, in whom these joints were stiff, we have no account of the habits. The fifth, a female, appears to have been a temperate person in comfortable circumstances, in whom no particular reason for the deformity of the joints can be assigned; and the same may be said of the sixth and seventh, except that the latter was in the habit of partaking rather freely of animal food, and also probably of the eighth, though we have not much information as to her past habits. It is rather remarkable that all of these, except the first, are females; of these females, three were poor, and the others in comfortable or in affluent circumstances.

Teeth.—The loss of teeth presents some interesting problems. It seems to be an associate of civilization, partly because the varied and peculiar conditions of civilized life tend to induce it, and partly because those conditions have the effect of preserving the body beyond the limits, which, under natural or uncivilized conditions, appear to have been assigned to it. Twenty-four of our centenarians had no teeth, some had been without them many years, and the average number retained was only four or five, which, in many instances, we may conclude to have been of little value. The artificial substitutes were used in so few instances, that we can not from them form an estimate of the aid afforded by these appliances in the prolongation of life; but that they do contribute to the maintenance of health and the prolongation of life can scarcely be a matter of doubt. The teeth had disappeared, as we have before found to be the case ("British Medical Journal," May 9, 1885, page 929) in the upper jaw more than in the lower; but the tables do not show so much difference between the men and the women as I then marked.

It is somewhat remarkable that, though as many as twenty-eight used glasses, thirty-five, including many who used glasses, are reported to have been in the enjoyment of good sight. The occurrence of presbyopia does not seem to be associated with, or to be a prelude to, inconvenience or impairment of sight beyond that which may be corrected by glasses. These had been used by some for forty or fifty years; and in three it appears that the defect was spontaneously rectified, and that as they grew older they became able to dispense with glasses.

That the majority of centenarians are content, as we find them to be, with three meals in the day, and are moderate or small eaters, partaking of little animal food and little alcohol, is in harmony with the lowered activity of the muscular and other organs, and the consequent lowered demand upon the nutritive processes and the nutritive supply. That nevertheless the rate of the pulse, averaging 70, and that of the respiration, averaging 22, is maintained, may be accounted for by the diminished elasticity of the circulatory and respiratory apparatus. The arteries become less capable of accelerating the blood-stream, and the vital capacity of the chest is much reduced, as shown by the slight difference in the chest-girth between the state of inspiration and that of expiration.

The sleep-duration, averaging nearly nine hours, indicates also a slowness, a feebleness, of the restorative processes. Repair is tardily and with difficulty striving to keep pace with wear. We know that it is one element in the developmental law of growth and decay, that it should not quite do so in the aged frame. Up to adolescence repair has the mastery, and the body gains in weight and strength; in middle age, repair is about equal to wear; but in later life its gradual failure, attended with diminishing weight and strength, conducts the body slowly along its normal course to dissolution. Long, good sleep, does something to put a drag on the downward course, and is a great sustainer of the aged frame. Much difference in sleep-duration is noted in the tables. In some, sleep is said to have been short and indifferent, or bad, perhaps owing to peculiar disturbing causes; but in 32 out of 44 it is said to have been good.

The maladies of these old people range themselves chiefly under the head of weakness, evinced by inability to put forth or maintain much effort of any kind, bodily or mental. Fatigue soon comes on; the muscular weakness proceeding to partial or complete loss of the use of the lower limbs, and to tremor of the upper limbs. The difficulty of penning a straight line resulting from this latter, being the cause of the smallness of the handwriting, often noticeable of old people. The weakness of the brain evinces itself in impairment of memory; in slowness of apprehension; in inability to fix the thoughts long on one thing; and the tendency, therefore, to wander from one subject to another, and to travel to and fro, which may pass on to want of control, or imbecility, or even to dementia. This last, saddest state of all, was witnessed only in two of our centenarians. Indeed, the brain in many held out as well as or better than other organs—which may be regarded one of the bright rays, if not the brightest, in the centenarian landscape.

The weakness, or failing, seems to have been about equal in the several great organs, showing that these organs presented to the last that good balance of enduring strength which is so essential to longevity. The lungs are, through life, the most sensitive to atmospheric changes, as well as to alterations in the conditions of the blood. Hence, bronchitic and pneumonic affections are a common source of distress, and a frequent cause of death at all periods of life; but it does not clearly appear that the very aged are more liable to them than those less advanced in years.

In the majority in our table, the action of the heart was regular, the pulse small and compressible, and evidences of arterial degeneration not manifest. In some of those who were auscultated, more or less *bruit* was heard, indicating some valvular or arterial roughness; but it made no apparent impression, and the individuals were unconscious of any defect. The slowness of micturition, mentioned in two men, and the incontinence in three females, as well as the frequency of micturition in three, may also be regarded as resulting from atony, rather than from disease. Indeed, these old people had outlived the period which is most liable to prostatic and other urinary troubles. Other minor maladies and discomforts, of which we may conclude that centenarians have their share, have, in many instances, probably been thought not worthy of mention.

Though the majority had suffered little from illness at former periods, some up to the very end of their long life, yet it is not unsatisfactory to find that the effects of illnesses, even when severe, do not always preclude longevity. One had rheumatic fever when young, and rheumatism afterward; one had epilepsy from seventeen to seventy; one had renal disease, with loss of sight, at thirty, from which there was complete recovery; one had an abscess connected with the spine, a stiff knee from injury at fifty, and diarrhœa from seventy-five to eighty, besides fevers and other ailments; one had gall-stones at sixty ; one was ten years in an asylum after a confinement ; one had peritonitis ; one had had fever at twenty-five, also jaundice and small-pox ; one had "bad-stroke" at sixty, for which she was bled, and two less severe strokes at seventy ; one had renal dropsy at eighty-two, lasting for two years ; one had acute bronchitis at ninety-five ; one had paralysis at ninety ; one had severe herdes zoster ; one had rheumatic fever at seventy ; one had severe bronchitis at eighty-two ; one had paralysis at seven ; four had fever—two of them badly.

The recoveries from illness at great age are to be noted. We find that one case recovered at eighty-two from renal dropsy, which lasted two years, and at ninety-eight recovered from a large slough on the thigh, caused by a bruise ; another from acute bronchitis at ninety-five, and pneumonia and erysipelas of the head at ninety-nine ; a third from rheumatic fever at seventy ; another from severe bronchitis at eighty-two ; and one from severe fever at eighty-four ; six had suffered injury to the hip after the age of ninety ; one broke the neck of the thigh-bone at ninety ; and one at one hundred and one, the latter so far recovering as to go on crutches.

Most interesting and important of all are the life-habits of these old people, among which activity, out-of-door exercise, and early rising, with moderation in diet and alcohol, stand out in strong relief, and are evidently among the important factors in longevity. At the same time, we perceive that most of them may be regarded as the attributes of the well-wearing body, that is to say, they are the resultants of health, as well as the promoters of it. The healthy, vigorous body can scarcely be otherwise than active in one way or other ; and few things tend to promote health and vigor more than activity—activity without excitement—an activity which is not forced beyond the measure of good and easy repair—an activity which does not wear the body out. The candle ought to burn briskly, and, as a general rule, at both ends, regarding the head or brain as one, and the limbs or locomotory agents as the other ; but it should not burn too fast ; and it may be that, in some persons, an extra rate at one end is better to be compensated by a lower rate at the other. Some persons, at least, seem to find that severe and continued brain-work is incompatible with much leg-work. Into this question, however, I will not enter.

Upon out-of-door activity, with the refreshing influence of open air, stress should be laid, for it must not be supposed that exercises and athletics indoors, where they are much more exhausting, are a sufficient substitute, especially in the case of young and growing persons.

Such activity causes a brisk trade in the nutritive market ; and the demand is pretty sure to be met by the supply, when food can be obtained. The moderation or spareness in diet, notably in the past habits of our centenarians, limiting the supply, prevents a wasteful overflooding of the market, and compels an economical and good employment of all that is brought there. Surplusage can do but harm. The body associates itself with a certain well-known evil agent in finding for idle food "some mischief still to do," although, in some individuals, a drainage for unused material may be made through the intestinal or renal or cutaneous organs, which, be it remembered, were never meant to serve that purpose, and which are likely to suffer from the strain thus put upon them. In many a more deleterious vent is found in gout, bilious attacks, etc., which, at the same time, cause a temporary arrest of supply, or in graver inflammatory attacks, or the still graver malignant affections. The temperance in all things of our centenarians has, without doubt, been one great means of keeping order in their nutritive system, and preventing aberrations into morbid processes. Few more mischievous notions have found their way into common acceptance than the idea that strength is proportionate to the amount of food taken; and it is accepted and mischievous, no doubt, in a greater degree than it would otherwise be, because it rests upon the basis of truth that strength can not be maintained without a sufficient supply of food.

The total abstainers will not fail to observe that twelve of our centenarians had been through life, or for a long period, in their ranks; that twenty took little alcohol; that this was, in the case of some of them, *very* little; and that eight were moderate. No. 8, it is true, often drank to excess on festive occasions; No. 14 was a free beer-drinker; and No. 35 "drank like a fish during his whole life," which probably means when he could, for it is added that "he could not usually get much." The exceptions, therefore, show little against the rule. It is, perhaps, scarcely less important to note that our centenarians were, for the most part, small meat-eaters.

The early rising was in many of the instances necessitated by their occupations. Still, this habit must be regarded as an associate or sequence of the healthful activity just mentioned, and of an activity pervading the reparative work which has to be done in sleep—an activity which quickly and thoroughly refits the body for its next day's work, and gives the energy, the willingness, the desire to resume it. Sleep should come quickly, be intense while it lasts, and cease quickly and completely; quite awake or quite asleep; no hovering between the two; no need of, or desire for, a little more slumber, a little more sleep. "When one turns in bed, it is time to turn out," whether rightly or wrongly attributed to the Duke of Wellington, is a saying worthy of him, and accords with the energy that contributed to make his life great as well as long.

While we thus gain more clear knowledge of the qualities for, and the adjuncts to, centenarianism, an examination of the table shows that there is no royal road to it. We see that it is attained under a variety of conditions, and that few persons can be said to be excluded from the prospect of it. With regard to certain of the important requisites, we can not alter our position. No one can make his family history better than it is, or make his body to be wound up for a longer period than its normal life's span; but it is the duty of each to endeavor to make it cover that span, and to go as long as its appointed time. The uncertainty as to that term, as it is one of the greatest blessings of life, so should it be one stimulus to us to ascertain and to follow the means most suited for prolonging life, especially as we find the result of our investigations to be that those are the means best calculated to turn it to good account and to make it happy.

Analysis of the Table of Centenarians.

By A. Francis, M. R. C. S., of King's College, Cambridge.

PRESENT CONDITION.

Age.—Fifty-two returns; average age, about $102\frac{1}{5}$ years. *Males.*—Sixteen returns; average age, about $102\frac{1}{4}$ years; respective ages, 108, 105, 104, 3 aged 103, 4 aged 102, 2 aged 101, $101\frac{1}{4}$, 3 aged 100. *Females.*—Thirty-six returns; average age, about $102\frac{1}{6}$ years; respective ages, 2 aged 108, 106, 3 aged 105, 3 aged 104, 4 aged 103, $102\frac{1}{2}$, 3 aged 102, 7 aged 101, $100\frac{3}{4}$, $100\frac{1}{2}$, 10 aged 100. In 11 cases, the age returned was verified by baptismal certificates or other records; of these, 2 were males, aged 101 and 100; and 9 were females, aged 108, 106, 104, 103, 102, 101, 101, $100\frac{1}{2}$, and 100.

Male or Female.—Fifty-two returns; M. 16, F. 36.

Single: Married: Widowed.—Fifty-two returns; S. 11 (of these 10 were females), M. 5, W. 36.

Affluent: Comfortable: Poor.—Fifty returns; A. 3, C. 28, P. 19.

Fat: Spare: Average.—Fifty returns; F. 9 (of these 8 were females), S. 23, A. 18.

Full-blooded: Pale: Average.—Forty-six returns; F. 8, P. 14, A. 24.

Strong: Feeble: Average.—Forty-eight returns; S. 20, F. 12, A. 16.

Figure: Erect or Bent.—Fifty returns; E. 25, B. 25.

Height. *Males.*—Twelve returns; average, about 5 ft. $8\frac{1}{2}$ in.; one also returned as short. *Females.*—Twenty-six returns; average about 5 ft. 3 in.

Weight. *Males.*—Seven returns; average nearly 138 lbs. *Females.*—Ten returns; average about 129 lbs. Respective Weights: *Males.*—182, 165, 147, 140, 120, 112, 98 lbs. *Females.*—196, 154, 140, 136, 126, 126, 120, 112, 112, 70 lbs.

Voice.—Forty-seven returns; loud, 6; clear, 16; weak, 7; full, 3; loud and clear, 8; full and clear, 6; loud and full, 1.

Hearing.—Forty-nine returns; good, 22; indifferent, 17; bad, 9; deaf, 1.

Joints.—Forty-seven returns; natural, 37; stiff, 4; deformed, 3;

stiff and deformed, 1; the last was stiff from chronic rheumatism, and deformed from contraction of palmar fascia; slightly deformed, 2; one of these was "from rheumatoid arthritis."

Sight.—Fifty-one returns; of these, 34 had good sight; 6 had cataracts, in one case unilateral, in another commencing; in 8 others, failure of eyesight was reported, apparently independent of presbyopia.

Glasses.—Thirty-five returns; 28 used glasses, 7 did not, but of these 4 were returned as "poor," and were possibly unable to read; 6 had used them for 40 to 50 years, 5 for 30 to 35 years, 4 for 10 to 20 years, 2 for 4 to 6 years, 5 for "many years," 2 for "few years." One had used spectacles for many years, but for last twelve years had been able to read without them; another had not used them for twelve years; another "not for many years," but one "can not now get them strong enough."

Digestion.—Forty-seven returns; good, 40; moderate, 7.

Appetite.—Forty-eight returns; good, 36; bad, 2; moderate, 10.

Eater.—Forty-six returns; moderate, 25; small, 9; large, 12.

Number of Meals Daily.—Forty-three returns; average number rather more than 3 daily; the greatest number was 5 daily (in 1 case); the least number was 2 daily (in 5 cases).

Alcohol.—Forty-six returns; none, 15; little, 24; moderate, 6; great deal of beer, 1.

Animal Food.—Forty-one returns; none, 3; moderate, 10; little, 25; very little, 2; much, 1.

Bowels.—Forty-three returns; daily, 26; alternately, 6; irregularly, 11.

Aperients.—Forty-one returns; rarely, 22; never, 14; frequently, 5.

Disposition.—Forty-six returns; placid, 14; irritable, 8; energetic, 11; placid and energetic, 8; irritable and energetic, 5.

Intellect.—Forty-six returns; average, 29; low, 5; high, 11; childish for six years, 1. One was said to be "slow in comprehending questions, but smart in reply."

Memory. Recent Events.—Thirty-nine returns; good, 26; bad, 6; moderate, 7. Past Events.—Forty-seven returns; good, 39; bad, 4; moderate, 4. One "remembers and will quote a great deal of the Bible," another could "repeat about 100 Psalms correctly."

Habits.—Forty-eight returns; active, 26; sedentary, 15; bedridden, 7; of these, 4 were males and 3 females; one, a male, had been bedridden for one year, and one, a female, for seven years.

Out-of-Door Exercise.—Forty-five returns; bedridden, 7; none, 16; of these, one "can walk very well," another "stays in bed in cold weather;" little, 9; one of these "mended the thatch of her cottage at 96, and was always the first home from church, being a rapid walker"; moderate, 1, she "goes to church twice on Sundays"; eight walk out; of these, one "walked four miles yesterday," another "walks daily half a mile, can walk three miles," another is "fond of sawing firewood;" two still work, one of these "attended Hexham market, two years ago"; one "worked in a field at 102"; one was "much out."

Smokes.—Forty-five returns; much, 7; four of these were women; little, 2; one was a woman; moderate, 3; one was a woman; none, 32; chews, 1.

Snuff.—Forty returns; none, 37; much, 1; this a woman who also smoked a little; little, 2, one being a woman, who did not smoke, the other a man, who smoked a little.

Sleep.—Forty-four returns; good, 32; bad, 5; moderate, 7; *Number of Hours.*—Twenty-nine returns; average rather more than 8½ hours; 3 slept 12 hours; 8 slept 10 hours; 1 slept 4 hours; and 2 slept 6 hours.

Hour of going to Bed.—Thirty-five returns; average, about 9 o'clock, one retired at 12 o'clock, one at 11, and 5 at 7 o'clock; 7 were bedridden.

Hour of Rising.—Thirty-five returns; average, about 8 o'clock; six rose at 6 o'clock, one at 5 o'clock, nine at 10 o'clock, one at 11 o'clock, and one at 4 p. m.

Chest-Girth in Inspiration. *Male.*—Six returns; average, 36¼ inches. *Female.*—Nine returns; average, nearly 31 inches. Male and female together, average about 33 inches.

Chest-Girth in Expiration. *Male.*—Five returns; average, about 36½ inches. *Female.*—Seven returns; average, nearly 30 inches. Male and female together, about 32½ inches.

Elasticity of Rib-Cartilages. *Male.*—Six returns; distinct, 1; indistinct, 5. *Female.*—Thirteen returns; distinct, 5; indistinct, 8.

Pulse.—Twenty-nine returns; average, 74·75 per minute. In some cases, disease of the heart or lungs was returned, and in others the pulse-rate was unusually high, and the condition of the heart and lungs was not detailed; excluding these cases, eleven in number, the average becomes 69·70 per minute. *Regular, Irregular, Intermittent.*—Twenty-eight returns; R. 24; Irr. 1; Int. 3. *Large, Small, Moderate.*—Twenty-seven returns; L. 9; S, 17; M. 1. *Compressible, Incompressible.*—Twenty-eight returns; C. 24: I. 4.

Arteries. *Male.*—Nine returns; even, 4; knotty, 2; tortuous and knotty, 1; tortuous, visible, and even, 2. *Female.*—Twenty returns; even, 8; tortuous, visible, and knotty, 3; visible and tortuous: 2; tortuous, visible, and even, 1; visible and even, 2; tortuous and knotty, 1; tortuous, 2; tortuous and even, 1.

Arcus Senilis. *Male.*—Seven returns; much, 4; little, 1; absent, 2. *Female.*—Nineteen returns; much, 5; little, 8; absent, 6.

Respiration.—Twenty-four returns; average, 24 per minute. Excluding those cases, eleven in number, in which heart or lung disease was returned, or in which the rate of respiration was high, and the condition of the heart and lungs was not mentioned, the average becomes 21 to 22 per minute. *Regular and Irregular.*—Twenty-four returns; regular, 21; irregular, 3.

Teeth.—Forty-two returns; 24 had none, and in 13 the teeth were specified. Among the 37 cases, there were 144 teeth: Upper jaw, 63—incisors, 19; canines, 8; molars, 36. Lower jaw, 81—incisors, 23; canines, 13; molars, 45. In five cases the number was alone given. Average (42 cases) 4–5 teeth. In one case, they "all came out whole." *Males.*—Fourteen returns; 6 had none; average, 4 teeth. *Females.*—Twenty-eight returns; 18 had none; average, nearly 5 teeth. Three females had a complete set, and another had 17 teeth; one male had 24, and another 16, teeth.

Artificial Teeth.—Thirty-eight returns; none, 34; yes, 1 (female); many years, 2 (male and female); from 50 to 90, 1 (female).

Evidences of Failure.—Thirty-five returns; none, 18; failures in 17 cases. *Heart*, 2.—In one, "sounds distinct, no murmur, very irregular, at one minute beating 60 to 70, and at another double as fast"; in the other, "circulation feeble, frequently sick and faint, as if she were going." *Heart and Lungs*, 3.—In one, "heart and lung sounds weak"; in another, "pulse intermits 6 times in a minute, impulse weak, slight bronchitis"; in another, "aortic regurgitation, slight bronchitis." *Heart and Urinary Organs*, 3.—In one, "loud systolic *bruit* at base, no appreciable interference with circulation, micturition frequent"; in another, "heart-sounds tumultuous and irregular, micturition frequent"; in another, "heart's action slightly irregular, not discernible in pulse, frequent micturition." *Lungs*, 2.—in one, "chronic bronchits"; in the other, "cough for four months." *Brain*, 3.—Senile dementia in two cases; in one, "childish for six years"; in the third case, apoplexy, right hemiplegia, aphasia, and death shortly after. *Brain and Urinary*, 1.—"Aphasia for 14 days, incontinence of urine." *Urinary*, 4. One had "some incontinence for ten years"; in two others, micturition was slow; and in another, "incontinence."

Micturition. *Male.*—Ten returns; natural, 7: slow, 2; frequent, 1. *Female.*—Twenty-three returns; natural, 18; frequent, 2; incontinence, 3—in one case for 10 years.—*British Medical Journal.*

Lamarck's Herbarium.—The botanical department in the Museum of Paris has just added to its collection the herbarium of Lamarck. On Lamarck's death this work passed into the hands of Mr. Roeper, Professor of Botany in the University of Rostock, who incorporated it with his own. On his death, in March, 1885, it was acquired by the Government of Mecklenburg-Schwerin for the University of Rostock. Professor Roeper's successor afterward offered it to the Paris Museum. The herbarium is contained in twenty-one voluminous cases, and comprises 10,000 species in perfect preservation, accompanied by labels and manuscript descriptions, and designs from the hands of the author.

HOW A NATURALIST IS TRAINED.

By J. S. KINGSLEY, Sc. D.

EVERY trade, every profession, has its own peculiar methods of procedure, which, while not kept secret, are still unknown to the general public. This ignorance is due to several causes, among which may be mentioned a lack of interest and a lack of any simple account of the processes involved. If one not educated to the legal profession be told the facts in a certain case, and then be turned loose in a large law library, how long would it take him to work up a brief? How would he know what books to consult, where to find decisions bearing on the cases in question, or, when found, how to interpret them, and ascertain their exact relations to the subject in dispute?

There is probably just as much mystery surrounding the way in which the naturalist investigates the secrets of Nature, yet the true student has not the slightest desire to conceal his methods; but, on the other hand, is perfectly willing, even glad, to tell how he arrived at his results to any one who wishes to hear. The student, on first entering a biological laboratory, thinks he has an easy task before him. All that he has to do in order to become a naturalist is to see and to remember what he sees. In a few days this confidence gives way to a spirit of despair. He begins to realize that observation is not so easy as he thought, and that the structures so distinctly shown in anatomical plates are not so readily discovered in the object before him. He becomes satisfied that in science, as in the other departments of knowledge, there is no royal road to learning. Gradually he acquires the methods, and knowing them his knowledge increases. What at first seemed an impossible task is seen to be really easy, and things at first invisible are soon as plain as day. At first sight it would seem difficult to take an egg, only $\frac{1}{100}$ of an inch in diameter, and cut it into slices in any desired manner, and yet it is an every-day operation to section such an egg and convert it into fifty slices.

It is the purpose of this article to tell in general terms the way in which a naturalist, and especially a zoölogist, arrives at his results. To give exact details would expand this article to a large volume and render it extremely abstruse and technical, while a mere outline will be much shorter and (the writer hopes) more interesting. Within the past few years the methods of study and tendencies of biological thought have undergone an immense development; and although each of the nearly four hundred colleges and universities in the United States pretend to give instruction in botany and zoölogy, there are really less than a dozen where the student can obtain a good and solid foundation in the biological sciences as they exist to-day.

Until school-life begins, a child is a good observer, but the whole training after that period is one adapted, if not intended to repress the forms of observation, and hence the first thing to be taught a student on entering the biological laboratory in one of the institutions of the better class is how to observe. This, though it appears an easy task, is really one of considerable difficulty. First, there is a tendency to consult books so as to learn what is or should be seen; and, secondly, there is a sudden jumping at conclusions from the most superficial examination of the specimen, and these conclusions are adhered to most tenaciously, utterly preventing the formation of any different view.

Together with the formation of habits of observation, it is desirable that a certain amount of facts be obtained, and so the student is set at the dissection of a selected series of animal types; for instance, the sea-anemone, sea-urchin, earth-worm, lobster, clam, and frog. Economy of material is insisted upon, and the admonition is frequently given that each stroke of the scalpel should mean something. Drawing is extremely essential, for, if the student be made to draw exactly what he sees, he will have to look more closely, and, at the same time, the instructor can readily see exactly how well his pupil works, and exactly where his difficulties lie. At first the student declares he can not draw, that he has not the slightest taste for art, and yet, after a very little experience, he makes thoroughly intelligible, if not artistic, representations of what he sees.

A very important point in making these small dissections is making them under water. If one attempt to dissect a clam in the open air, the various parts will settle down and adhere to each other; while, if the operation be performed under water, this difficulty will be avoided, the parts being buoyed up by the surrounding medium. To trace the course of the blood-vessels, injections are resorted to. Some quickly hardening mass, like plaster-of-Paris or melted wax, or gelatine colored by carmine, vermilion, or Prussian blue, is forced into the arteries or veins, and then the student, by following the streaks of color, can readily follow the course of the circulation. When sufficient skill is obtained by dissection of these larger forms, smaller ones may be taken, and after a short time the student experiences but little more difficulty in dissecting a grasshopper or a snail than in a pigeon or turtle.

Besides obtaining a skill in dissection and a capacity for observation, a student is led in this anatomical course to make comparisons between the various objects dissected. This results in a recognition of similarities and differences, and exercises the reasoning faculties. The value of the mathematical sciences in logical training is often insisted upon, but to the writer it seems as if the biological sciences were even more important from this standpoint. In mathematics, given such and such premises, there can be but one conclusion; there is no alternative, while in zoölogical reasoning there is an element of uncertainty to be eliminated. Each fact observed must be weighed, and its relative importance determined, before conclusions can be drawn, and even then it is frequently necessary to estimate the relative probability of two or more alternatives, thus giving an exercise to the powers of ratiocination which is utterly lacking in the remorseless logic of the mathematical theorem.

When this general foundation of facts and methods is obtained, more special studies are taken up; and since embryological research includes most of the processes involved, we will suppose that the student is next introduced to this fascinating field which is now so assiduously cultivated by scholars all over the world. As a rule, it may be stated that animals living on the land or in fresh water differ considerably in their mode of development from their near relatives in the sea. Many ancestral features which are retained in marine forms have become eliminated in the others, and hence the study of the growth of salt-water forms from the egg to the adult throws far more light on the relationships and ancestry of the different groups than does that of the terrestrial and fluviatile species. Again, the sea affords a wealth of life far beyond that of the land and fresh water, a wealth to be estimated not only in number of individuals but of species as well. Whole groups of animals are solely marine, while others are represented on the earth or in rivers and ponds by a few small and insignificant forms.

For this reason the student of embryology betakes himself every year to the shore, so that, while being recuperated by the sea-breeze, he may continue his studies and add to the total of human knowledge. Marine laboratories for this purpose are scattered the whole length of our coast, from North Carolina to Eastport, some being mere temporary affairs, others permanent stations. In 1885 public or private laboratories existed at Beaufort, Newport, Nantucket, Wood's Holl, Salem, Annisquam, Mount Desert, and Eastport. The absolutely necessary furnishings of such a laboratory are extremely few, but to them one may add as far as purse and inclination admit. There must be tables, chairs, and glass dishes, while each student must have a microscope and accessories. Then come a boat (a row-boat is sufficient for all ordinary work) and apparatus for collecting. Finally, a small stock of chemicals and apparatus for microscopical work complete the list of necessities.

Possibly the most common way for obtaining material for embryological study is by use of the skimming-net. This consists of a brass ring about a foot in diameter, to which is attached a net of fine gauze and cords for dragging it behind a boat. The whole operation of skimming is very simple. Two persons are required, one to row the boat, the other to attend the net. The latter allows the net to trail behind, keeping the cords so that part of the mouth is above and part below the surface of the water, so that as much as possible of the surface-water will be strained through the gauze. At intervals the net is hauled in, turned inside out, and rinsed by immersion and agitation in a bucket of water kept in the bottom of the boat. In this way everything entangled in the meshes of the net is transferred to the pail. The net is again put out and the operation repeated.

Skimming may be performed at any hour of the day; but in the daytime the forms collected will differ considerably from those captured at night, and, besides, will not be nearly so numerous. The best place for skimming is a spot where two tidal currents meet, forming a line of scum upon the surface; the best time is in the evening, when the surface of the water is calm and smooth. Then the wealth of forms and individuals is almost incredible, and no one who has never seen the operation can have the slightest conception of the results. Each time the net is hauled from the water it shines like molten gold from the phosphorescence of the myriads of animals by which it is covered. On closer examination it is seen that spots of other colors exist among the prevailing yellow light: bright red, blue, bluish-green, emerald-green, and white occur, and after some experience one learns to recognize the presence of a few species by the color of the light.

Only two or three hauls of the skimming-net are necessary to insure an abundance of material for study, and at no time need the student spend more than half an hour in this work, while frequently ten or fifteen minutes are ample. The laboratory is now sought, and the contents of the bucket in which the net was rinsed are poured into shallow glass dishes placed between the student and a lamp. Then, and not till then, does one begin to realize the enormous amount of life in the sea. In half an hour's skimming not a thousand gallons of water will pass through the net, and yet but a single glance at the dishes convinces one that millions—yes, millions—of individuals have been captured! The water is roily with minute animals and embryos, whirling, dancing, and jerking about in the strangest manner.

On different nights the relative proportion of forms will vary. To-night not a single specimen may be taken of a species which last night was very abundant; but at all times a large proportion of the captures will be found to be copepod crustaceans—small forms not over a quarter of an inch in length, which swim about in a jerky manner by means of violent strokes of their long antennæ. To enumerate all the forms which might be taken by skimming would prove a difficult task, but some of the more prominent forms are readily recognized by the peculiarities of their motions. The crustacea move by jerks, the embryo worms and mollusks, on the other hand, whirl away in a mazy waltz; while the jelly-fish swim lazily away by the languid contractions of their umbrellas.

While a general view of the results of surface-skimming is interesting and instructive, our student has other work before him. He is to take one species of embryo and follow it through its transformations. Soon after the dishes are placed before the light, most of the forms will be found congregated at the lightest side of the dish. A lamp seems to exert the same fascination on them as on the moths of a summer's night. The student, armed with a magnifying-glass, now picks out from the dish the forms he desires to study by means of a medicine-dropper, and transfers them to a separate dish, where they may have an abundance of water, and, when sufficient material has been picked out, the real study begins.

The first thing is to ascertain everything of the external and internal structure that can be seen in the living animal. For this purpose it is placed on a glass slide in a drop of sea-water and carefully studied under the microscope. In this, as in all embryological work, drawing is absolutely necessary. Pages of description will not take the place of pictorial representation. After the whole is studied, then comes a study of the different parts, drawings and notes being made of each. An embryo is continually growing, and it becomes necessary to take into account every stage of growth. The embryo of to-morrow will be different from that of to-day, and the changes must be recorded. Some of the embryos are therefore kept, the water being changed, as often as necessary, and these serve for to-morrow's study, the drawings of to-day furnishing a basis of comparison. In many cases it is a comparatively easy task to rear embryos until the adult condition is recognizable, but at other times it is found impossible to keep them in confinement for more than two or three days. In the first case it is an easy task to identify the forms studied, but in the other the difficulty is considerable. Subsequent skimmings must be made in the hopes of securing the later stages of development, while an endeavor to find the animal which produces the eggs frequently meets with success. Comparison with the studies of other investigators is also an important aid to identification.

If, however, the eggs are taken directly from the parents, this trouble is wholly avoided, although other difficulties are introduced. Suppose, for instance, that one wishes to study the development of one of the fishes, the first step is to obtain males and females with the generative products ripe. A gentle stroking will serve to expel both eggs and milt, and then these are mixed together and "artificial impregnation" is affected. In the case of worms, oysters, and clams, the same result can be obtained by mincing the generative organs of ripe males and females, mixing them together, and then straining off the larger portions which, by their decay, would soon pollute the water. In the case of crabs and shrimps the eggs are borne attached to the abdominal legs of the mothers, and by capturing these females an abundant supply of material can be obtained. The parents can readily be preserved alive in lobster-cars or similar contrivances, and furnish eggs as they are needed.

Artificial impregnation is a very valuable process, for, by its aid, every stage in development may be obtained. Eggs and milt may be mixed under the microscope, and all the phenomena of the maturation of the egg and its impregnation can then be followed as well as the processes of segmentation which result in the conversion of the single-celled egg into the many-celled embryo. Interesting as a description of these phenomena would be, we must pass them by, for we have not yet described one of the most important processes of study.

Studying embryos, even the most transparent ones, by simply watching them under the microscope, leaves many features of the method of formation of the internal structure unknown, while in the case of opaque forms it reveals not a single feature except those of the surface. A knowledge of these internal points is, however, just as important as of the external modifications of form. In many, yes, in almost every case, the embryo is too small to be dissected, but by converting it into a series of slices or sections, and then studying these, structures and processes of growth are revealed which otherwise would remain entirely unknown. This method of section-cutting and the processes of preserving the sections thus obtained is almost entirely a growth of the last ten years. It is true that for a long time naturalists have resorted to it, but so crude were the instruments and so faulty the *technique* that section-cutting could hardly be said to exist in comparison with its importance to-day.

Here, as elsewhere, details would be out of place in an article of this character, but an outline of the processes involved in section-cutting will show the capacities of modern research as well as the methods which our student must master before he can take his place among the advanced workers of to-day. It must be said, in passing, that for every form some process is best adapted, and that what works well for one is often utterly unsuited for a closely related species. No general rule can be laid down by which the student can at once say that such and such methods are best adapted to give good results; the exact course of procedure in any case can only be determined by experiment.

Were it attempted to cut the fresh egg into sections, the result would be an ignominious failure. There are various preparatory processes necessary, and in all of these care must be exercised that the reagents employed do not produce abnormal effects. First, the egg must be hardened, and here there is a choice among a number of chemicals—alcohol, chromic acid, bichromate of potash, osmic or nitric acids, corrosive sublimate, etc.—each of which has its especial advantages and disadvantages. Even in the method of killing the egg previous to hardening, there are a number of methods to choose from. The hardening reagents all serve to kill, but not equally well, for they do not all work with the same rapidity. In the use of all, care has to be exercised to prevent contraction.

Were we to cut the hardened egg, our sections, without further treatment, would reveal but little, for they would be very transparent, and one portion would closely resemble another. So staining is resorted to, and, where practicable, it is preferable to stain before cutting the sections. Of stains for microscopic purposes there are many, and the value of each depends upon the fact that the different elements of cells and tissues will absorb it in varying quantities. Most used of all is some preparation of carmine which stains certain portions red, leaving others uncolored. Of these carmine solutions the student has no less than twenty to choose from. Next in order comes hæmatoxylon, or extract of logwood, which, when combined with alum, stains certain portions blue or purple. Osmic acid also stains a brown or a black, according to the structure and the length of exposure. Nitrate of silver is also frequently used for certain purposes, while of the anilines only eosin and Bismarck-brown have any great value.

In order to section the egg we must employ some means to hold it firmly, and for this purpose various substances are employed, paraffin or celloidin being the most common. The requisites of an imbedding substance are that it be possible to make it thoroughly impregnate every part of the egg, and also that it be of such a consistency as to be readily cut into the thinnest sections. The egg is imbedded in paraffin by completely replacing all the water in it by alcohol, this in turn by some solvent of paraffin, as turpentine or oil of clove, and then by keeping it for a time in melted paraffin. Then egg and paraffin may be cut as if only paraffin were present. In the case of celloidin (a solid form of gun-cotton) the intermediate reagents are alcohol and a mixture of alcohol and ether. The process involves some time to accomplish thoroughly, and here, as elsewhere, neglect of details is sure to result in failure.

In order to cut the sections, special instruments (microtomes they are called) have been devised, and are now made of a high degree of accuracy and excellence. So delicately are they made, that it is possible to cut an egg into a series of sections so thin that it would require twenty-five or even more of them to equal in thickness the paper on which this magazine is printed. In the early days of section-cutting no such facilities were available, and the apparatus described in the hand-books of microscopy even five years ago were utterly inadequate to produce good results. Of modern microtomes there are now four distinct types in use, two having the knife stationary, the other two having it moved through a fixed and definite plane. It is not necessary to describe these here; those who wish may find accounts and figures of them in recent works, like Whitman's "Methods of Research in Microscopical Anatomy and Embryology."

Very recently a new "kink" has been introduced into section-cutting which has relieved the student from a great deal of drudgery. It has been found that by trimming the block of paraffin square, and by having the edge of the section-knife at right angles to the line of stroke, the successive sections would adhere together by their edges, and form long ribbons, and that thus a large number of sections could be mounted as readily as one by the former method. For some purposes this serial section-cutting" has no especial advantages, but where it is desired to preserve every section it is indispensable. To mount them, however, requires special processes. The one most in use is the following:

A glass slide is coated on one side with a mixture of clove-oil and collodion, which forms a viscid, sticky surface. On this the ribbons of sections are laid and then the whole is exposed for some time to a gentle heat in a water-bath. This melts the paraffin and allows the section to drop into the sticky mixture where every part, even if separate from the rest, is firmly and securely held in its proper position. A continuation of the heat evaporates the clove-oil until the sections are fastened to the slide by a thin film of pure collodion. The paraffin is now washed away by turpentine or chloroform, Canada balsam and a bit of thin glass are applied, and then every section is permanently preserved and ready for study, it may be immediately or in a year or two.

Usually most of the time spent in a summer marine laboratory is devoted to studying the external features of development and in preparing material and slides of sections which can be examined more carefully later. With a slide which contains all of the sections cut from a single egg the student can reconstruct all the details of the embryo and can trace the course and limits of every organ and vessel. By comparing this with the sections of a later and an earlier stage, he sees how the organs arise, and how during growth they are modified in size and shape, as well as in their relations one to another. In studying the living embryo, time is not taken into account. It usually happens that material is obtained late in the day or in the evening. It takes no rest, but develops minute by minute, hour by hour, and the student, if he really wishes to master his problems must be reconciled to turn night into day. His egg is changing constantly, and, with pencil in hand, he sits with one eye to his microscope, watching the growth. Hour after hour thus passes away, each minute revealing some new feature, until at last his eyes tire and he is forced to quit. He seeks his bed with regret, for he has been compelled to leave some of the most interesting objects that the human eye ever saw. Consider for a moment the differences between an adult fish and its minute egg, clear as a drop of dew, and then try to imagine the changes which are necessary to convert the one into the other. Such things as these our student was forced to leave, and leave, knowing that the egg would not wait for him, but on the morrow would be far advanced, and there would be a great gap in his notes. While he was looking, it seemed as if he could almost see actual personal life. Changes were constantly occurring: now he saw a cell divide into two, just as though a knife had passed through it; again, he was seeing the way the cells thus formed were arranging themselves in layers and building up the embryo. Such scenes as these have a fascination beyond description, and the student can not repress the feeling that, could he wait a little longer, or were his microscope a little more powerful, he could actually see the force that accomplished these marvelous results. On the morrow, when he returns to his study, the feeling is the same, and no matter if he be witnessing some phase of development, even for the hundredth time, he is as interested as at first. At such times it seems as if the solution to the great problem, "What is life?" were really close at hand.

So far it has been an easy task to describe the process of conversion of an untrained person into an original investigator, but there is another side—a psychological one—which baffles description. All that is necessary in order to perform the various operations which have been thus briefly outlined are power of observation and skill in manipulation; but the facts thus gained must be interpreted in order to render them of real value. A paper which merely details the facts observed of course has its value; but if it adds a comparison of them with the phenomena which occur in other forms, and tells or even suggests their meaning, it then takes a far higher rank. This, however, takes thought, and who can describe the way in which one thinks?

The student tries to master every fact in the development of his embryos, and then compares these facts with what was already known of the development of other forms. In this way he recognizes similarities and differences, for both of which explanations are to be sought. Even in the development of the specimen studied there are many phenomena which have their own meaning, and which, properly interpreted, throw much light on its ancestry and line of descent. In general terms this interpretation is effected by framing an hypothesis which will embrace some of the facts, and then testing it in every conceivable manner. When an objection arises, the first step is to see if it really be founded on fact, or upon a misconception, and then, if it be valid, the attempt is made to reconcile it with the hypothesis. It frequently happens that several hypotheses are formulated before a satisfactory one is found.

Such in brief outline is the training, or rather a part of the training, which is necessary to make a naturalist to-day. The time is past when one can collect a few bugs or shells and then straightway proceed to describe so many new species. Description of species is a necessary work, but it is not the highest kind of work. Far more important, far more ennobling, far more interesting are the deeper problems of how an animal grows, why it grows in the way it does. The training necessary for work of this character requires as long a time, as much patience, and as much perseverance as does any of the so-called learned professions; but when one becomes an original investigator there is no respite. It means continual work, continual study. If one stop, even for less than a year, he can never catch up. Others have been at work while he was idle, and he is left behind. Pecuniarily a naturalist's work does not pay; the same amount of energy and ability spent in any other direction would bring in ample recompense, but here it does not. It does, however, have its own reward: every new fact discovered gives the student far more pleasure than any money could; each new advance into the *terra incognita* of Nature lightens the inconveniences of poverty.

And now the question may arise, What is the use of discovering the secrets of Nature if there be no money in it? Yes, that is it. Everything must be reduced to a basis of dollars and cents! The utilitarians who propound such questions do not and can not see any value in learning for learning's sake; it must bring some pecuniary reward. In some instances it is readily seen that such studies have a direct influence in curing or ameliorating some of the ills that human flesh is heir to; in other instances their exact bearings are not immediately apparent. Just one hundred years ago an Italian physician, Galvani by name, discovered some facts which, while interesting, must have seemed at that time wholly without practical bearings. To-day no one can deny that they were fraught with great good to mankind. What would the world be without electricity as a servant? Yet Galvani's experiments contained the germ of all our numerous electrical discoveries. Who can say but that biological studies are to have an equal value in solid gold?

CELEBRATED CLOCKS.

By FREDERIC G. MATHER.

WHEN the Emperor Charles V of Spain retired to the Monastery of St. Yuste, he took with him Torriano, his clock-maker, in order to while away the time by constructing the movements of clocks. So wonderful were some of the pieces of work which they made, that the monks would not believe any one except the devil had a hand in them, until the machinery was shown to them by the ex-emperor. It was ordered by Charles that when he should die all of these clocks should cease running—and it is said to be a fact that his orders were obeyed.

Another king of Spain came to Geneva to see a clock which had been made by Droz, a merchant of that city. Upon the clock were seated a shepherd, a negro, and a dog. As the hour was struck, the shepherd played upon his flute, and the dog played gently at his feet. But, when the king reached forth to touch an apple that hung from a tree, under which the shepherd rested, the dog flew at him and barked so furiously that a live dog answered him, and the whole party left in haste. Venturing to return, one of the courtiers asked the negro, in Spanish, what time it was. There was no reply; but, when the question was repeated in French, an answer was given. This frightened the courtier, who rejoined his companions, and all of them voted that the clock was the work of the evil-one.

Upon the belfry of the Kauthaus, in Coblentz, there is the head of a giant—bearded, and helmeted with brass. The giant's head is known as "the man in the custom-house"; and whenever a countryman meets a citizen of Coblentz away from that place, instead of saying, "How are all our friends in Coblentz?" he asks, "How is the man in the custom-house?" At every stroke of the bell which sounds the hours upon the clock, the mouth of the giant opens and shuts with great force, as if it were trying to say, in the words of Longfellow, "Time was—Time is—Time is past."

The "old clock of Prague" stands near the old Hussite church—the machinery forming a part of the original tower, and the egg-shaped dial being shown on the street. It was the work of Hanusch, who died in 1499. So jealous of the other cities were the citizens of Prague, and so afraid were they that the other cities might bribe Hanusch to build as good a clock somewhere else, that they declared he was insane, and put out his eyes. The dial, which is between six and eight feet across, has a number of hands which mark not only minutes and hours, but also days, months, years, and centuries. What else it will do has been told in this way by a poet:

"At the left of the dial a skeleton stands,
And aloft hangs a musical bell in the tower,
Which he rings, by a rope that he holds in his hands,
In his punctual function of striking the hour.

"And the skeleton nods, as he tugs at the rope,
At an odd little figure that eyes him aghast,
As a hint that the bell rings the knell of his hope,
And the hour that is solemnly tolled is his last.

"And the effigy turns its queer features away
(Much as if for a snickering fit or a sneeze),
With a shrug and a shudder that struggle to say,
'Pray excuse me, but—just an hour more, if you please?'

"But the funniest sight, of the numerous sights,
Which the clock has to show to the people below,
Is the Holy Apostles in tunics and tights,
Who revolve in a ring, or proceed in a row."

On the dial-plate of a clock in St. Mark's Cathedral, in Venice, the twenty-four hours of the day are represented by the signs of the zodiac and the phases of the moon. The Madonna is seated on a platform over the dial. Whenever a religious festival occurs, an angel comes out from a door at one side of the platform, blows a trumpet, bows to the Madonna, and passes out at another door. The three wise men of the East then come in at one door, bow to the Madonna, and pass out. Two giants strike the hour on a bell, while the winged lion of St. Mark overlooks the whole scene.

We are told of a strange clock that is said to have belonged to a Hindoo prince. A large gong was hung on poles near the dial, and all about, upon the ground, lay a pile of artificial human heads, ribs, legs, and arms. The whole number of bones in the pile was equal to the number of bones in twelve perfect bodies, but the pile appeared to have been thrown together in the greatest confusion. "When the hands of the clock indicated the hour of one, out from the pile crawled first the number of parts needed to form the frame of one man, part coming to part with quick click; and, when completed, the figure sprang up, seized a mallet, and, walking up to the gong, struck one blow. This done, he returned to the pile, and fell to pieces again. When two o'clock came, two men arose, and did likewise; and at the hours of noon and midnight the entire heap sprang up and, marching to the gong, struck one after another his blow, making twelve in all; then returning, fell to pieces as before."

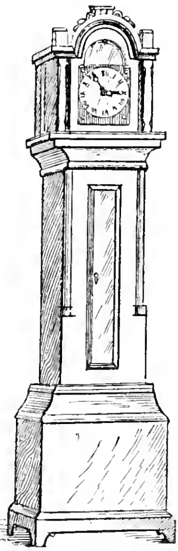
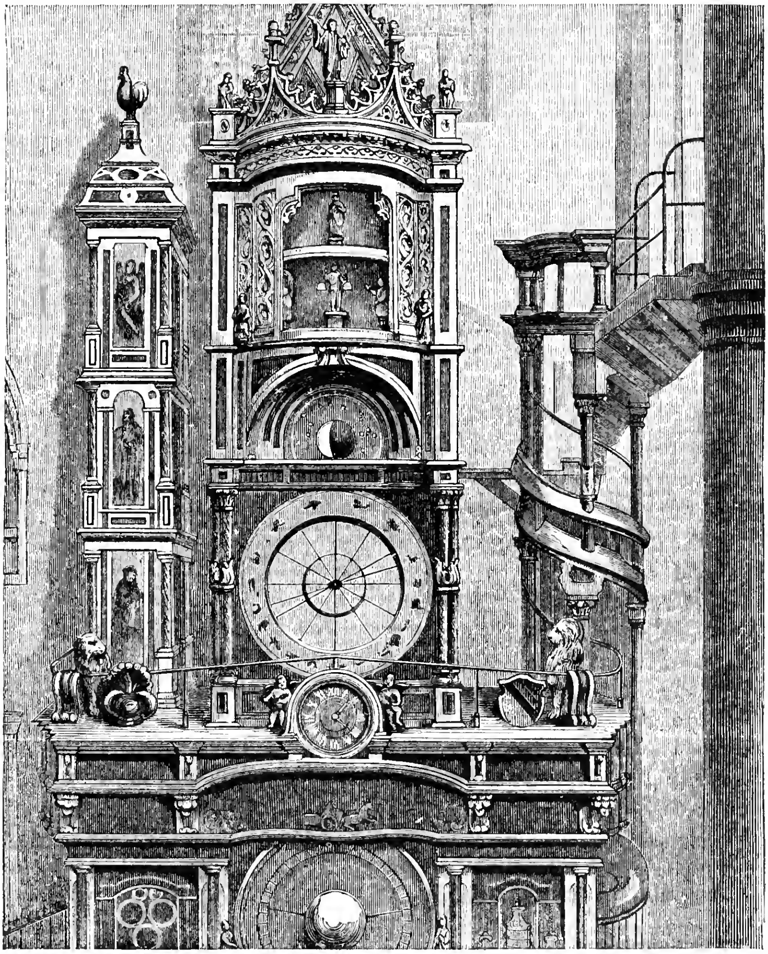


Fig. 1.—My Grandfather's Clock.

An old traveler writes this description of a clock that he saw in Japan: "This clock, in a frame three feet high and five long, represented a moon landscape of great loveliness. In the foreground were plum and cherry trees and rich plants in full bloom; in the rear a hill gradual in ascent, from which flowed a cascade, admirably imitated in crystal. From this point a thread-like stream glided along, encircling rocks and tiny islands in its winding, but presently losing itself in a far-off stretch of woodland. In the sky turned a golden sun, indicating as it passed the striking hours, which were all marked upon the frame below, where a slowly creeping tortoise served as a hand. A bird of exquisite plumage, resting on a plum-tree branch, by its wings proclaimed the expiration of each hour. When the song ceased, a mouse sprang from a grotto near by, and, running over the hill, hastily disappeared."

By far the most famous clock in the world is the one that is hidden inside the cathedral in Strasburg (Fig. 2). The first clock—with automatic figures—was begun by Bishop Van Bucheck in 1352, and finished by Bishop von Litchenberg in 1354. The present clock was begun in 1547 by Christian Herlin, Nicholas Bruckner, and Michael Herr. The death of the two latter delayed the work, and it was not resumed until Professor Conrad Dasypodius, of the university, furnished plans for its completion in 1570. The brothers Isaac and Josiah Habrecht executed the mechanical work; and Tobias Stimmer carved the wood casings and ornaments. The work was completed in 1574, under the superintendency of David Wolkenstein. It stands to-day—just as it has stood for over three hundred years—a very elaborate piece of workmanship, thirty feet high and fifteen feet wide



THE FAMOUS ASTRONOMICAL CLOCK.

Fig. 2.—The Famous Astronomical Clock, Strasburg.

at the base. On one side is a flight of winding stairs surmounted by five emblematical Corinthian columns. On the other side is a Gothic pillar, the panels of which are filled with paintings of human figures. In front of the base a large globe shows the equinoxes and the positions of the sun and moon. Another arrangement in the base shows the movements of the several planets. A calendar, also, shows what are fast-days, holy-days, and feast-days. Above all of these interesting things there is a long opening which extends across the width of the base. On each day of the week a different figure appears at one side of this opening, at noon it is in the center, and at night it disappears altogether at the side opposite to the one by which it entered in the morning. The figure on Mondays is that of Diana ; on Tuesdays, it is Apollo. Just above these figures, and in the very edge of the platform that forms the top of the base, is the dial of the clock which tells the hour and minute of the day. On either side of the dial sit two Cupids, one of whom strikes the hours and quarters on a bell, and the other reverses an hour-glass as each new hour begins. Above, and on the real body of the clock, is placed a dial containing the signs of the zodiac. Then over this there is a ball which shows the age of the moon—whether it is first quarter, or full, etc.—while overhead are concealed the various images, or automatic figures, that appear only at noon. What an eye-witness saw by waiting from eleven o'clock till noon has been thus described : "We viewed this wondrous piece of mechanism for an hour, and witnessed the following movements : At a quarter-past eleven the Cupid near the dial struck one ; then, from one of the upper compartments ran forth a little child with a wand, and as he passed he struck one on a bell, and ran away (Childhood the first quarter). Round whirled the wheels of time, and the second quarter chimes ; but this time it is Youth that passes, and taps the bell with his shepherd's staff twined with flowers. After we leave the second quarter, then Manhood strides forth, the mailed warrior, and smites the sonorous bell, ere he leaves the scene, three sounding blows with his trenchant weapon—the third quarter. Once more the hands tremble on the point of noon ; the fourth quarter is here, and Old Age, a feeble, bent figure, hobbles out, pauses wearily at the bell, raises a crutch, and taps four strokes, and totters away out of sight—'last scene of all' ; when, as a *finale*, the skeleton figure of Death, before whom all four have passed, slowly raises his *bâton*, which the spectators now discover to be a human bone, and solemnly strikes the hour of twelve upon the bell. While he is engaged in this act, a set of figures above him, representing the twelve apostles, pass in procession before the Saviour, who blesses each one as he passes before him in turn ; and chanticleer, the size of life, perched upon the pinnacle of one of the side structures, lifts up his voice in three rousing crows, with outstretched neck and flapping wings ; while the Cupid on one side of the dial reverses the hour-glass for the sand to flow back, and the other Cupid strikes the hour with his bell and hammer."

There are many other wonderful clocks in the world, but they are smaller, and they are not as well known as the Strasburg clock. An old time-piece in England records the age of all the planets by an arrangement which gives the exact revolution of each one. For instance, the little ball that represents Mercury goes around the circle once in about three months ; Venus, once in seven months ; the Earth, once in a year ; Mars, once in nearly two years ; Jupiter, once in nearly twelve years ; Saturn, once in about twenty-nine years ; Uranus, once in eighty-four years ; and Neptune, once in one hundred and sixty-five years. Besides giving the golden number, the dominical letter, and other interesting things, this clock gives the time when it is high tide at various points in Europe. A clock made by a Parisian consists merely of a glass dial, and two hands, which are balanced each with a ball on the other side of the center. These balls (Fig. 3) are only about an inch in diameter, and yet they contain all the machinery that turns the hands about. The back of the dial is a perfectly smooth surface. You may turn the hands round and round with your cane, and when you let them alone they will swing back and forth for a while, and then they will stop at exactly the right spot to show the true time. A clock in Brussels is so placed over a chimney (or pipe through which the air goes upward) that the draught keeps it wound up all the time.

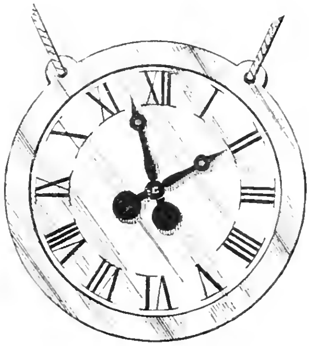


Fig. 3.—Parisian Clock.

The most artistic clocks for mantels are, for the most part, made in Paris or Vienna. One variety has a tuning-fork for controlling the escapement. Another hides the working parts of the clock within a base that shows only the dial (Fig. 4). Upon this base stands a female figure holding a pendulum which vibrates without any cause that any one can see. But if the figure is taken off from its base it will be discovered that it rests upon a pivot which is connected with the escapement in such a way that it is swayed to and fro just a moment before the pendulum has reached the limit in the opposite direction. This sends the pendulum back again, just as you reverse the motion of a rocking-chair by leaning forward just before you have rocked back as far as you are going. Sometimes the female figure (Fig. 4) holds above her head a great ball, which is balanced by a pendulum that swings near her feet. The ball contains the clock, and inside of it is a small pendulum, controlled by a spring in such a way as to send the large pendulum back and forth after the manner of a rocking-chair. There are also clocks that are run by electricity instead of by weights.

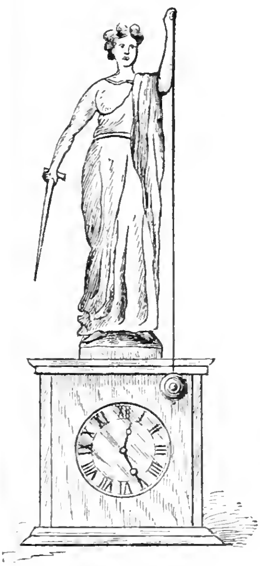


Fig. 4.—Parisian Clock.

The largest clock in the world is the one in the British House of Parliament at London, known as the Westminster clock. Its four dials are made of iron and glass, in such a way that they can be brilliantly lighted at night. They are one hundred and eighty feet from the ground, and their diameters are twenty-two and a half feet—a size which makes them larger than any dials in the world save one, at the cathedral at Malines, and that one has only an hour-hand. The minute-hand of the Westminster clock jumps nearly seven inches every half-minute—this kind of action by a remontoir-train being considered better than the old way of having the wheels move all the time as they do in an ordinary clock. The train (Fig. 5) is about fifteen feet long

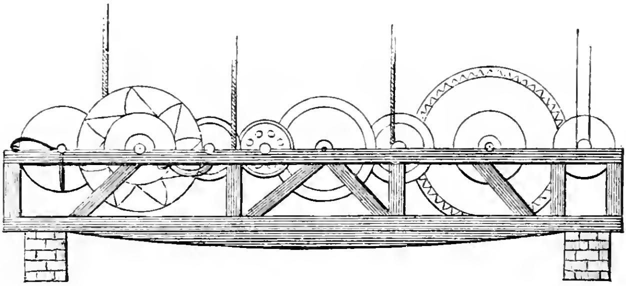


FIG. 5.—PRINCIPAL PARTS OF WESTMINSTER CLOCK, LONDON.

and nearly five feet wide. The escapement is known as the "three-legged double"; and any error is corrected at the Greenwich Observatory, whither the great clock telegraphs its time twice every day. The train of wheels that carries the hands is wound up once a week; but the train that controls the striking part is wound up twice a week. The great, or hour, bell is nine feet in diameter, weighs 30,000 pounds, and can be heard at a distance of ten miles. The quarter-hour bells can be heard four or five miles, and they weigh 8,000, 3,700, 2,800, and 2,350 pounds respectively. The present clock was first set going in 1859, and it cost $110,000. The cost of the movement of striking-work was $20,000; of the hands and dials, $26,500; of the bells, $30,000. The site of the clock has been occupied by some kind of a public time-piece for the past six hundred years. We read that on this spot the first Westminster clock was erected in 1298; and that in 1365 Edward III erected a tower containing a clock and a great bell, upon which the hours were struck.

If we inquire where the clocks that are made to-day come from, we shall find that France sends out the largest number, measured by a money value. Then come in order Switzerland, the United States, England, Austria, and Germany. In Germany there is a district known as the Black Forest, in which thousands of people follow the trade of clock-making, and so have their fathers and grandfathers for a great many years. In the United States, almost the only clock-makers, down to the year 1800, were Daniel Burnap, Eli Terry, Silas Merriman, Thomas Harland, Timothy Peck, and James Harrison—all of Connecticut. In those days an ordinary house-clock cost sixty or seventy-five dollars without the case, and this was because all of the works were made by hand. From these few clock-makers has sprung the great clock-making industry which supplies clocks that are sold cheaply, because the various parts are made by machinery. American clocks of this sort go all over the world, and even into the Black Forest! Fine and delicate astronomical clocks are also made in the United States. We hear of clocks that run in a vacuum, and which wind themselves; and of large clocks at a central point which drive other clocks all about the city by the force of compressed air. The latter are called pneumatic clocks. We also read of a magnetic clock which requires no power or force for its running save the magnetism of the earth.

There are many other clocks of American make that deserve to be mentioned, but we have not space enough to do so. We must be fair toward our own mechanics, by telling of three or four clocks that have been made in the United States. There is one known as the "Columbus Clock," because it was made by a citizen of Columbus, Ohio. The maker was only thirty years old when the work was done, and it had taken him eight years to complete it. The clock stands about eighteen feet high by eleven wide. It shows not only the revolution of the earth on its own axis, but also its position in its orbit about the sun. The positions of the other planets in their orbits are also shown. There are miniature models of the signing of the Declaration of Independence; of President Lincoln emancipating the slaves; and of the Strasburg clock. A wonderful walking-man is also one of the attractions.

Another American clock was made in Donaldson, Pennsylvania, by a native of Germany, who took seven years to whittle it out of a log. All around and below the dial there are groups of automatic figures. At the top is Napoleon, and the horse that is said to have eaten apple-dumplings. Both Napoleon and the horse (the automatons, I mean) partake of what are supposed to be dumplings. Then we have Captain Jack, chief of the Modocs, who summons his warriors by striking the hours upon a gong. Just below the dial Jonah is being swallowed by the whale, after having been thrown overboard from the vessel. In another part Christ is walking on the water toward a group of disciples that crowd the deck of a ship. Noah's ark, the "good fairy and the poor woman," and several other figures, go through their movements, while a music-box within the case of the clock gives forth appropriate tunes.

The most remarkable clock in America, if we consider the place in which it was built, is the one that was made by a miner in the Hallenback colliery, at Wilkesbarre, Pennsylvania. This clock was made out of bits of board and iron, and with the roughest tools that can be imagined. It was made nearly half a mile underground, and it occupied the maker nine years before he could say it was done. The clock is about nine feet high, and there are sixty-three figures that move by machinery. There are only twenty-two moving figures in the Strasburg clock. On the front of the Wilkesbarre clock—the one we are speaking of—there are three shelves or balconies. Along the lower balcony a mounted general leads a file of Continental soldiers. The liberty-bell rings, and a sentinel salutes the procession. A door in the upper balcony opens and shows Molly Pitcher, who fires her historic cannon, the smoke of which is blown away from the interior of the clock by a fan. Then the portraits of the first twenty Presidents of the United States pass along in a kind of panorama, the Declaration of Independence being held aloft by Thomas Jefferson. On another of the balconies the twelve apostles go by; Satan comes out, and the cock crows for the benefit of Peter. When Christ appears, a figure of Justice raises a pair of scales, while a figure of Death tolls the minutes upon a bell.

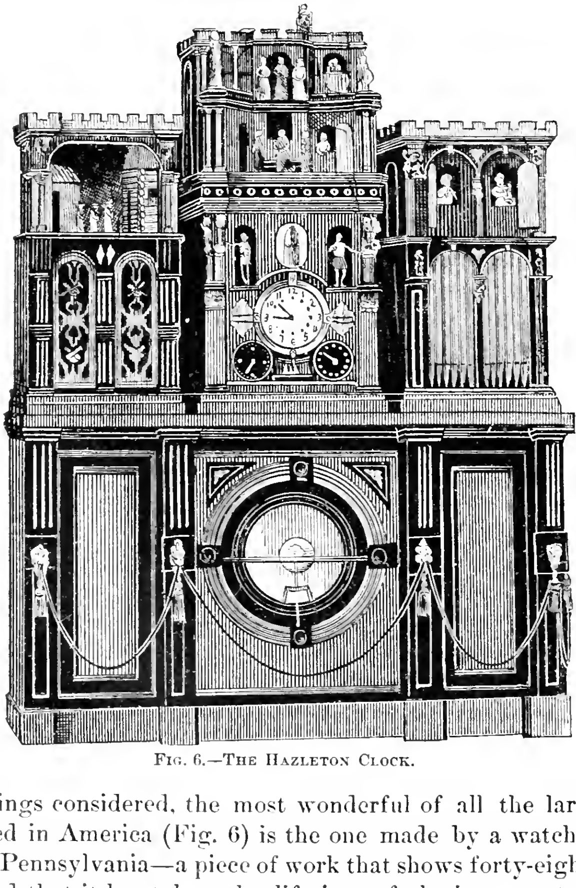


Fig. 6.—The Hazleton Clock.

All things considered, the most wonderful of all the large clocks constructed in America (Fig. 6) is the one made by a watchmaker of Hazleton, Pennsylvania—a piece of work that shows forty-eight moving figures, and that it has taken the lifetime of the inventor to produce.

The base of the clock contains a revolving horizon, which shows the motion of the constellations. A six-inch globe, representing the earth, turns on its axis once in twenty-four hours; and about this globe a moon completes the circuit once in twenty-nine and a half days. All the machinery for producing these movements is in plain sight. The central part of the case above the base contains several dials showing the tides, the season of the year, the phases of the moon, the day of the week, and the day of the month. The largest of these dials has the hours and minutes. Just over this dial there is an oval niche where Youth, Manhood, and Old Age appear in turn as the hour goes by. An alcove at the right contains Father Time with his scythe, bell, and hour-glass. An alcove at the left holds a figure of Death, which is ready to strike the hour with a thigh-bone upon a skull. Above these images are the doors where Christ, the Apostles, and Satan appear and disappear. The figure of Justice is close at hand. Still above the Apostles is an upper balcony where the three Marys appear. To crown all is a battlement, whereon a Roman sentinel paces back and forth. At the right of the main instrument above described a smaller tower contains an organ, which gives forth music during the march of the Apostles. Above the organ Orpheus and Linus appear with pipe and harp, but only while the organ sends out its strains. At the left of the main instrument a third tower represents the battle of Monmouth, and Molly Pitcher with her well-known water-keg.

The wonderful things that are done by the main part of the clock may be described thus: When the hour-hand approaches the first quarter, Father Time reverses his hour-glass and strikes one on the bell with his scythe. Youth then appears. Three minutes before the half-hour, a bell starts a tune from the organ. At the half-hour, Time again reverses his glass, strikes two on the bell, and Manhood appears. One minute afterward a chime is heard, and the Saviour steps forth from a door. The Apostles pass by—Peter in the center and Judas at the rear. The three Marys also come forth at the upper balcony and stand facing the spectators. Each one of the Apostles bows when opposite the Saviour, and the bow is returned. But Peter turns away—which is a signal for the cock to crow, for Satan to appear at the upper window, and for Justice to raise her scales. Judas does not look at the Saviour; but Satan follows behind him in the procession, to be sure that he does not bow, and then turns backward and disappears, only to reappear at an upper window. In fact, Satan appears in six different places. At the third quarter, Time strikes three, and again turns the hour-glass. Manhood passes by, and Old Age comes upon the scene. Three minutes before the hour the organ sounds once more; when the hour arrives, Death strikes the number on the skull, and the Apostles once more begin to move before the Saviour.

What is known as the "Rittenhouse Clock" is, in many respects, a more wonderful piece of mechanism than the clock that we have just described. It is very much smaller than the Hazleton clock, and readily stands in the corner of an editor's office in Philadelphia. This editor—who controls one of the leading papers in that city—has more than fifty clocks, many of them very rare and costly, but the Rittenhouse is superior to all the rest. It was made in 1767 by David Rittenhouse, after whom Rittenhouse Square in Philadelphia is named. The clock has six dials. On the main dial in the center there are four hands, which point out the seconds, minutes, hours, and days—the latter giving one day more to February in leap-year. The phases of the moon are also given. The second dial shows the movements of the planets about the sun—each planet being represented by a golden ball. The third dial shows the moon revolving about the earth. The fourth dial shows how Saturn is getting along in his twenty-nine-year journey around the sun. The fifth dial shows whether the sun-time is fast or slow in comparison with mean meridian-time. The sixth dial discloses a combination of chimes which sound the quarter-hours, a choice of the tune to be played being had by turning a hand to any one of ten numbers, and a repetition of the tune is caused by pressing on a knob upon the dial.

A great many people nowadays appear to have taken a fancy to the tall clocks that are intended to stand in the corner of a room. They are sometimes called "grandfather's clocks"; and a great variety of them may be found all through the New England States, but more especially in Salem, Massachusetts, and Newport, Rhode Island. A number of English clocks from Virginia have recently come into the possession of the dwellers in Newport in a roundabout way. It seems that during the war of 1861 the negroes frequently stole the tall clocks and took them to their cabins. But, as the ceilings of the cabins were so very low, the clock-cases had to be sawed off, both at the top and at the bottom. Several years afterward a live Yankee came along and bought a great many of the shortened clocks, took them home, repaired them, and sold them at very high prices. Of course, all of these clocks give the old, new, and full moon, the tides, etc., and occasionally one of them has a music-box. A good story is told of a lady who drove a long distance into New Jersey to buy an old clock that would play tunes. Having brought it home, she found that it needed repairing badly; and so she took it to a repairer of clocks. Now, this repairer did not know how important it was, in the mind of the lady, to have the clock play very old tunes. Therefore, when he saw that the musical-box part of the clock must be replaced with something else, he put in a cylinder that contained several modern tunes. When the clock had been repaired it was sent home. The lady called in her friends to congratulate her upon her purchase. All of the visitors waited eagerly for the old tunes to be played; but, instead of that kind of music, the machinery struck up "The Babies on our Block"!

There is a very delightful way in which you may tell the hour of day by means of flowers. And this is really the most wonderful of all the clocks that have been or can be made, for it requires no winding and no weights, and no hands and no wheels. There are twenty-four varieties of plants whose blossoms open successively at the different hours of the day and night. I will mention only three or four. The African marigold opens at seven in the evening and closes at four in the morning; but, if it does not open, the next day will be rainy. Many varieties of the water-lily close and sink into the water at sundown, to arise and bloom at sunrise. The day-lily opens at five o'clock in the morning, and the morning-glory a little later. The night-blooming cereus opens only at night, and it closes long before the first streak of dawn.

COMPARATIVE PSYCHOLOGY: ITS OBJECTS AND PROBLEMS.*

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THE term comparative psychology, in its modern sense, gives us the widest desirable scope as including all that pertains to the mind or soul of the animal kingdom. It may have been at one time considered as highly impertinent to ask whether the lower animals possess mind, and to substitute the term soul would have been dangerously suggestive of heterodoxy of a type rapidly to be extinguished. However, few persons of any degree of culture will now be found prepared to deny that the inferior animals have minds. The questions now to be settled are: What kind of minds? In how far do they resemble, and in how far differ from, our own? Few, it is true, have considered that they sufficiently resemble the human mind to make it worth while to investigate the subject at all. Probably the great mass of persons have been led to believe that man does and always has occupied a distinctive and wholly isolated position in the universe of life—a center around whom and for whom all other forms exist. This view seems to me totally unwarranted by the state of our scientific knowledge at the present day. Further, it is a view not only without scientific foundation, but calculated to lead to pernicious practical results.

By experiments on the lower animals, and by this means almost wholly, has the science of physiology been built up. We argue from the case in animals to the case in man, and consider the inferences thus derived valuable, even final—possibly too much so; but we are

* A presidential address delivered before the Society for the Study of Comparative Psychology.

apt to ignore the psychological similarity. From experiments on the brains of the lower animals we argue as to the nature of the brain of man. Why not pursue the comparative method for the soul?

This condition of things can be traced to the influence of views still surviving, unscientific, as we believe, as to man's origin and place in the universe. At all events, such views exist and influence practically our treatment of the lower animals. Where man is concerned, their rights are very seldom considered. The question is not raised as to whose rights are paramount, but it is tacitly assumed that when man is involved the brutes have none. That such views have been up to the present time operative to the neglect, and often the positive annoyance, if not the actual persecution and death of unoffending creatures, will be perfectly plain to any one who will take the pains to examine into the case.

If there is to be order in the universe, it must be conceded that where respective interests clash in certain cases, that interest, and that creature of less importance must give way to the one of greater importance; but man can never act righteously to his fellow-creatures lower in the animal scale, till he recognizes that he is of them not only in his body but in his mind; in other words, that they are truly fellows, or, as some one has expressed it, "poor relations." But let this not be said in any pitying sense, for it can be most clearly shown that in not a few respects not only are these "poor relations" equal but superior to man.

Physiologists have long been familiar with the higher development of the senses in animals below man. There is not a single sense that man possesses in which he is not excelled by some one animal, often immeasurably.

Many of the performances of the lower animals, if accomplished by men, would be regarded as indications of the possession of marvelous genius. In the brutes they are regarded as the outcome of "mere instinct," by which is meant an endowment acting blindly and incapable either of philosophic explanation or of modification. While the fact seems to be that instincts, as they exist, are the result of inherited experiences accumulated through considerable periods of time; that they may be modified, and are constantly being modified by new experiences; that they may be lost or replaced; and much more that we have still to learn. Many of the instincts of animals are so far removed from any knowledge or faculty we possess that they are at present inexplicable. But man must learn to say, "I don't know," about a great many things still, instead of assuming the validity of explanations which are not true solutions at all, but mere assumptions.

And at this point allow me to indicate a danger that should make us cautious and modest in attempting to explain the behavior of animals. We infer from our fellow-man's behavior similarity of motive and mental processes to our own under like circumstances. We find, the more experience we have, that we are often at fault as to both. And when we are more free from the thralldom of so-called systems and methods in education, we may learn that the activities of the human mind can not be reduced in all persons to precisely the one plan, like so much clock-work. This may mar somewhat the completeness and beauty of our philosophy of education, but it may also in the end conduce to human progress by providing the greater freedom, and end in insuring an individuality of character which seems to be now rapidly disappearing. Now, if individual men so differ in psychic behavior, how much more is it likely that still greater differences hold for the lower animals! An objection may be based, however, on this to the whole study of comparative psychology. The objection holds to some extent even for human psychology; but, as we infer, similarity of behavior in men to denote similarity of inner processes, so are we justified in the same as regards the lower animals, though it must be conceded somewhat less so. We must always be prepared to admit that there may be psychic paths unknown and possibly unknowable to us in the realm of their inner life. But if we regard man as the outcome of development through lower forms, according to variation with natural selection—in a word, if a man is the final link in a long chain binding the whole animal creation together, we have the greater reason for inferring that comparative psychology and human psychology have common roots. We must, in fact, believe in a mental or psychic evolution as well as in a physical (morphological) one.

It is not inconceivable that special faculties which do not exist in the lower animals have been implanted in man; but the trend of investigation thus far goes to show that at least the germ of every human faculty does exist in some species of animal. Nor does such a view at all derogate from the dignity of superior man, while it links the animal creation together in a way that no other can. It opens up the subject for genuine scientific study; it tends to beget a respect for the lower creation, which, while it fosters modesty in man, also furnishes a foundation for broader sympathy with those lower in the scale. The opposite view may lead to our pitying the brute, but can scarcely yield as good moral fruit. Let but an individual man assume that by virtue of something he possesses he is radically different from his fellows, and what is the result? Your genuine aristocrat (in feeling) is a sad stranger to humanity in general.

But where shall we draw the line? Formerly the line was drawn at reason. It was said the brutes can not reason. Only persons who do not themselves reason about the subject with the facts before them can any longer occupy such a position. The evidence of reasoning power is overwhelming for the upper ranks of animals, and yearly the downward limits are being extended the more the inferior tribes are studied. Perhaps the highest faculty man possesses is that by which he generalizes and forms conceptions of the *abstract*. That animals have imagination or the power to frame mental pictures of absent objects, the grief of the dog at the absence or loss of his master amply proves, as does also the capacity of animals to dream. If, as some assume, abstraction is a necessary part of reasoning, then it must of course be conceded that animals have the power of framing abstract conceptions. There is a certain amount of evidence that some animals can count within narrow limits. It is scarcely possible to account for the conduct of the horse, dog, elephant, and ape, under certain circumstances, without believing that they have the power to generalize upon details. Once concede the power to form abstract ideas, and there is then the basis for any other faculty man possesses that is considered usually as peculiarly his.

Have animals a moral nature, or are they capable of forming a conception of right and wrong? The answer to this introduces the question as to method of comparison. Should the highest of the inferior animals be compared with the most civilized races of men, or with man in his most degraded condition? That neither of these comparisons is just, can be shown. As capacity for education is one of the best evidences of mental ability in both man and inferior animals, and as man's civilization is the outcome of his own intellect, he must be credited with this as evidence of his superiority.

It is to be remembered, however, that each marked advance in progress has been made by the few great intellects that have appeared, and only accepted, not originated, by the many; that but for permanent records in language, much of man's civilization would have been lost as rapidly as acquired; that man's civilization is the growth of thousands of years, beginning with a condition of things scarcely if at all higher than that now known to some tribes of animals; that what any child becomes is really largely dependent upon the training it receives; the child of the savage, and that of the civilized man, can not be compared any more than the latter and the inferior animals. Now, the reverse of all this holds for the lower animals. So far as any systematic training from man is concerned, they are very much as they were thousands of years ago. Before it were possible absolutely to compare the highest man and the highest animal, it would be necessary that for ages the effect of culture should be tried on the lower animals. The astonishing results achieved in the lifetime of a single animal, and the results attained by the creation of hereditary specialists as among dogs, put the whole matter in a light that shows our usual comparisons to be somewhat unfair. If the highest among dogs, apes, and elephants be compared with the lowest among savage tribes, the balance, whether mental or moral, will not be very largely in man's favor—indeed, in many cases the reverse.

We are not contending for the equality of man and the rest of the animal kingdom; even assuming that the child and the dog have equal advantages, the child will still be in many respects superior to the dog; but we are desirous of pointing out how much has been overlooked in all these comparisons between man and the lower animals. It will be noticed that all those species of animals which have for ages been in contact with man, have made great advances over their wild progenitors, evidencing a capacity for education—mental and moral—which is one of the best demonstrations of superiority.

The assumption that man is only accidentally the superior of the brute would but lead to confusion, for it must be admitted that there is a scale, and that man ranks first. We are simply desirous of doing the lower creation that justice which we feel assured has not yet been allowed them, and of seeing the human family interested in those that we think scientific investigation is proving constantly are much more our fellow-creatures than has generally been supposed.

If we compare the intelligence and general rectitude of behavior of our best races of dogs with the same in any of their wild carnivorous allies, we are astonished at the great difference in favor of the dog. To what is this due? Largely to what he has become by virtue of association with man for hundreds if not thousands of years—that is, to education, after a fashion. Nor is such influence confined to the dog. Any observing person, of moderate experience in travel, can call to mind numerous instances of members of different classes of animals trained to the performance of many feats demanding intelligence. But, while in an irregular way dogs have been trained to certain duties for the benefit of man for a considerable period, it can not be said that any one of the tribes of the lower animals has ever been subjected to any such mental or moral discipline as man receives and has received for long ages. We have ample evidence, in the condition not only of savage man, but in the neglected classes of large cities, as to what man would be without such culture. Sufficient has been said, it is believed, to show that we are not yet in possession of enough facts to enable us to determine exactly the limit of mental and moral capacity in the lower animals. As yet, we neither know adequately what they are or of what they are capable. Both these subjects are worthy of human investigation. Their elucidation must tend to give man a better knowledge of himself, if only by contrast.

To return to the question of the moral nature of animals. The study of the dog alone, both in the light of observations accumulated in the literature which are often true of special individuals in a degree not of the average animal (a fact which does not, however, at all invalidate their force), the study of any dog we may ourselves own, can not but convince us that a sense of right and wrong is possessed by that animal. It may be that the dog does not rise to these conceptions as understood by the learned divine discoursing from the pulpit; but neither does a large proportion of the congregation when transacting the business of the week. It may be, and perhaps is, largely true that the right with the dog means what is in accord with his master's will; that is, the dog may end at the stage in which every child, even the most highly endowed, is found at *some* period of his development. It is a condition unquestionably in advance, by far, of that of scores of tribes. Moreover, as in the child and the less endowed morally of men, even such ideas of the right are powerfully operative in producing courses of useful conduct. They lead to action on the one hand, and to restraint on the other, instances of which, in the case of the dog, are abundant, and some of them of a most touching, we might almost say ennobling, character. To affirm that the idea of right and wrong of the lower animals does not rise above the hope of reward and the fear of punishment is not to keep to the facts, unless we include as the only reward, in many cases, the master's approbation, and the only punishment his displeasure. When a child arrives at such a stage of feeling, most persons would not be inclined to deny it a moral nature and a very good one, too. We might almost speak of a dog having a religion, with man as his deity. But as a whole host of qualities—some of them difficult to classify—go to make up the character of the human individual so developed and balanced as to deserve the epithet "gentleman," so there are many qualities in the best specimens of the canine race that we can practically appreciate better than define.

In all such discussions it must be borne in mind that if we adopt the theory of organic evolution we are almost bound, of necessity, to a belief in the origin and gradual development of mind from the faintest glimmerings of consciousness, in the simplest protoplasmic creatures; and that system will be most philosophical and complete which can fill up the gaps between the lowest manifestation of any quality and the highest. Hence, many are inclined to believe that the great distinction between man's faculties and those of animals lower in the scale is *difference in degree and not in kind*, certainly in so far as they run parallel. Such a view does not prevent our conceiving of additional forms of psychic activity not represented in man as the possession of the brutes. That such seems probable will appear when we discuss some of the problems still demanding solution. Nor does such a view imply that there may not be avenues of knowledge of a special kind open to man which are closed to those lower in the scale, such as a special revelation from a higher source. So far as we see, indeed, there are no theological difficulties any more than with evolution as ordinarily applied to animal and plant forms.

Man's present superiority over the lower animals is traceable in large part to his eminently social tendencies, resulting in the division of labor, with its consequent development of special aptitudes and its outcome in the enormous amount of force which he can, on occasion, bring to bear against the various tendencies making for his destruction. Indeed, the isolated individual man is scarcely as well prepared in the struggle for existence as most other animals. But the extent to which animals do continue, it may be in pairs or in larger numbers, to defend themselves against enemies ; hunt down prey; rear young ; elude enemies ; overcome difficulties in travel ; work in concert in the preparation of dwellings, and in many other instances, has been but inadequately considered. And in many such cases it is quite impossible to explain these things by that refuge of the unthinking or prejudiced, "instinct." The limits of an address of this kind do not, of course, permit of detailed evidence being adduced for the views maintained. Such evidence is, however, within the observation of all to some extent, and is, so far as the literature is concerned, found in elaborate form in the admirable writings of Romanes and Lindsay more especially. Thus much by way of clearing the ground, of preparing the mind for a careful and earnest study of our fellow-creatures of the lower grades, without prejudice and without fear of any loss of self-respect by the concessions we may be obliged to make.

As to how, so far as the study of comparative psychology itself is concerned, the objects of this society may be best advanced, let me now endeavor to indicate briefly. A great part of the material available is found in literature of very varying reliability. In many cases there is so obvious a prejudice in favor of the particular animals whose performances are described, that very large deductions must be made. We shall do well to be more than cautious in what we accept. At the same time much that can not be regarded as wholly reliable may prove suggestive and serve as the starting-point of investigations. But there is no reason why many points now bearing the character of uncertainty and indefiniteness might not be submitted to the test of experiment. Doubtless not a few supposed facts would vanish into thin air if subjected to such examination. However, I must at the same time state that a careful perusal of the accounts of the experiments of even the most skillful investigators by this method, with its clearly defined but artificially arranged conditions, has convinced me that such do not wholly meet the case. They bear with them the danger of fallacy against which one must constantly be on the watch. It must always be considered that the great question is, not how an animal's mind *may* act, valuable as that may be, but how it normally *does* act; that is to say, what are the natural psychic processes of the class of animals under investigation? The same cautions, in drawing conclusions, must be observed in the allied science of physiology, one in which the conditions can be much more accurately regulated. Plainly, it will be desirable to keep our *facts* very sharply apart from our explanations. The science of psychology is a very youthful one, that of comparative psychology still more so ; and, at the present stage of the science, any one who contributes a single fact will be a real friend to their progress. We must endeavor to secure a large number of correspondents who will furnish accurate accounts of phenomena in this realm, of which they have been themselves the observers. We must place all material coming at second-hand by itself, not as worthless, but as calling for special scrutiny. But so long as we have facts only, we have no science; such, indeed, are as the wood and stone for the building, and, unless worked up into scientific form, may prove an incumbrance. Let me, then, briefly indicate some of the problems that have seemed to myself and others as most urgently demanding solution.

One of the questions still far from clear is that which we had under discussion last year, viz.: In how far can the lower animals understand man's various forms of expression, especially his spoken words? *A priori*, we should not expect that creatures unable to invent words should have the capacity to understand them in the sense in which man himself does. I am inclined to think that more has been claimed for the inferior races of animals in this direction than an exact examination of the subject will warrant. On the other hand, we have probably very much underrated their capacity to comprehend our various forms of unspoken language. The subject calls for close observation. A kindred problem is the degree to which various kinds of animals can communicate with one another. This is a much more difficult subject, and it may prove that the creatures we despise as so very much inferior may have modes of subtile communication which we are, possibly, incapable even of comprehending.

The whole subject of the senses of the lower animals is a field for investigation both by the psychologist and the physiologist; all the more important, as it is scarcely possible to understand one form or degree of sensation adequately, except by comparison with its lower and higher forms. The field is as yet but little tilled, but enough has been done to suggest this very important question: Do the senses of the lower animals and those of man differ only in degree, or also in kind? Is the sense of smell, e. g., in the dog, merely more acute, or is it not also characteristically different? The latter seems the more probable, when we consider how different the hearing of man is in some respects (music) from that of other animals, even the dog.

Among wholly unsolved problems ranks the nature of the mental processes by which many different tribes of animals find their way back to the place from which they have been removed when the distances involved are great, and often when they have never traveled, so much as once the way by which they return.

Akin to this, possibly, though perhaps quite different, is the question as to the nature of the faculties by which animals are enabled to migrate. "How a small and tender bird coming from Africa or Spain, after traversing the sea, finds the very same hedge-row in the middle of England, where it made its nest last season, is truly marvelous" (Darwin). We are much in need of more *facts* in regard to the migrations of animals; and it is hoped that the systematic work recently inaugurated by the American Ornithological Association may lead to useful results in this field. With regard to the so-called "homing instinct," it has been noticed that savage or semi-savage man possesses a power of finding his way in the trackless forest by more accurate observation than that of which the civilized man seems capable. While this throws light upon the case of the lower animals, it does but very inadequately explain it. It may turn out that both of these puzzles are susceptible of simple explanation; but at present they strike me as rather belonging to that class of psychic phenomena the meaning of which can be but inadequately understood by man, owing to his not possessing the requisite faculties or those faculties in sufficiently powerful or acute development. The performances of a Shakespeare and Scott in literature, or a Beethoven in music, to the mass of men, must be but imperfectly understood in any proper sense of *realization*. Probably these sons of genius could have given little account of the "manner of it" themselves. We might hesitate to call such faculties as the above in the lower animals genius, or to acknowledge any kinship; but genius among men is often as limited and as disassociated with general mental power as are certain marvelous faculties in the lower animals. It may be that migration is accomplished by means of some forms of acute sensation, according to which the animal acts more or less blindly. Plainly, no mere restless impulse can account for the performance, though it may initiate it. These and many other problems are before us; and, like most recondite problems, they will require the labors of many, each bringing his little for their solution. But is it not worth while? Man can not live by bread alone. We hunger for completeness in our knowledge and harmony in our philosophy. But, apart from this philosophical satisfaction, it can not but prove for the interests both of man and the lower animals that the latter should be better understood.

Belonging, as most of you do, to the veterinary profession, or, as I should prefer to call it, the profession of comparative medicine, either as students or as practitioners and teachers, the more you comprehend the mental workings and modes of expression of your patients, the more successfully must you arrive at an accurate knowledge of their symptoms, and so be the better prepared to relieve the suffering among them, and in so doing also advance man's material interests. To you, at the present time, must we especially look for diffusing more enlightened and humane views, views worthy of this renowned school of comparative medicine, which many of you have come so far to attend. It will be for you to intervene in cases of public panic like that witnessed in connection with the recent hydrophobia scare; reassure the public mind, and protect our fellow-creatures of the lower ranks from needless molestation. There is probably no class of men whose daily life-work gives them so large an opportunity for at the same time acquiring and diffusing truer views in regard to the lower animals. Your enthusiasm and success during the first year of our existence as a society, have been a matter of equal surprise and delight to me, especially considering how fully you are occupied with the ordinary duties of your profession. We hope to enlist the interest of others and bring them into our ranks, to accumulate a library of books bearing on this subject, secure a large number of correspondents from widely separated parts of the continent, and in various other ways stimulate the study which we feel calls for and is worthy of man's earnest attention.* I can not close this address without making grateful reference on behalf of this society to the kind manner in which, in many ways, Principal McEachran, and the professors of the Veterinary College, have lent their support to our projects.

THE GIANT BIRDS OF NEW ZEALAND.

By HORATIO HALE.

THE discovery of the Dinornis by the illustrious zoölogist, Richard Owen, is famous as one of the most notable feats in the history of science. From a single imperfect bone, a femur broken at both ends, he deduced the fact that an enormous bird of the Struthious order, but far exceeding the ostrich in size, formerly inhabited New Zealand. This discovery, published in 1839, aroused much interest, and led to further inquiry. Four years later, Owen was able to show, from the comparison of many fragments of skeletons which had reached him, that there had been at least six species of these gigantic birds. With additional materials, in 1850, he had increased the number of species to eleven, classed in three genera, and varying in size from a kind no larger than the great bustard (or about five feet high) to one—the Dinornis giganteus—at least ten feet in height. Still later researches have shown that even this stature was in some instances surpassed, and that birds must have existed in New Zealand whose height attained fourteen feet, or twice that of the largest ostrich.

When Owen's first paper on this subject was published, the only white residents in New Zealand were a few missionaries and traders. Since then it has become one of the most flourishing of British colonies, especially distinguished for the educated intelligence of its people. Several scientific associations exist among them, whose members pursue with zeal their researches into the natural history of their

* This young society, so far as known, the only one in America for the study of comparative psychology, is composed at present almost entirely of the students and teachers of the School of Comparative (Veterinary) Medicine in Montreal, though its membership is open to all eligible persons. On behalf of the society, the president takes this opportunity of soliciting written accounts of accurate personal observations bearing on the subject, especially on any of the obscure problems treated in this paper.

islands. These huge extinct birds were, of course, among the first subjects of investigation; and soon a decided and very remarkable difference of opinion appeared. It was known from the first that the native inhabitants were accustomed to speak of these birds under the designation of *moa*, the name that in the other islands of Polynesia, from the Navigator group to Hawaii, was applied to the common domestic fowl, which was not known in New Zealand. The first inquirers, including Owen's missionary correspondents, had assumed, as a matter of course, that the Dinornis had existed in very recent times, and perhaps was not even yet extinct. But a class of skeptical investigators arose, who took a very different view. The leader of this school was Mr. (now Sir Julius) Haast, a distinguished geologist and naturalist, the author of a valuable work on the "Geology of the Provinces of Canterbury and Westland," and of many other treatises, in which, admitting the coexistence of man and the moas at a very remote period, answering to our prehistoric time—as man and the mammoth are known to have existed together in Europe—he denies that the present race of Maoris had ever known those great birds. In his view these creatures represented in New Zealand the gigantic quadrupeds which inhabited the northern hemisphere during the Post-pliocene or Quaternary period. If any of them survived that epoch, they had become extinct at an early day, and long before the ancestors of the modern Maoris had found their way to New Zealand.

Mr. Haast's view had in itself a certain plausibility, and it was maintained by himself and his followers with much firmness against many objectors, who brought forward a strong array of facts on the opposite side. The controversy has at length drawn the attention of one of the most eminent of European zoölogists, Professor de Quatrefages. In an elaborate and very interesting paper on "Moas and Moa-Hunters," which has recently appeared, he sums up the controversy with judicial thoroughness, reviewing carefully all the published data, from the time of Owen to the latest contribution to the "Transactions of the New Zealand Institute," and comes to the conclusion that the earlier inquirers were right, and that Mr. Haast's view, in the form in which he proposes it, can not be sustained.* Indeed, the mere facts themselves, as they are set forth in this admirably lucid exposition, are overwhelming in their force, while the scientific skill with which they are marshalled, and the wealth of illustration which enforces the conclusions, are such as might be expected from the accomplished author.

He shows that many eggs and fragments of eggs of the moas have been discovered; that many feathers belonging to different species of these birds and to various parts of the body have been gathered in different places; and that even portions of the skeleton have been found which had muscles, tendons, and pieces of skin still adhering,

* "Les Moas et les Chasseurs de Moas," par M. A. de Quatrefages, pp. 43.

with some feathers, all in a remarkable state of preservation. Nor were these preserved in ice, like the Siberian mammoth; they had simply been dried in the sand, and the bones had not been in the slightest degree mineralized. Further, the traditions of the natives about these birds are perfectly clear. They describe their size, their shape, their habits, and the manner in which they were hunted. The native proverbs refer to them. It was the habit of the male and female of these birds to go constantly together, and the Maoris speak of fighting "two against two, like the moas." They had a particular kind of obsidian knife, which they used in cutting up these birds at their feasts. The prayers or incantations which they were accustomed to recite before setting out on a moa-hunt are still remembered. Such a hunt was a serious undertaking, for the monstrous game could crush a man with one blow of the foot. The very paths which were made by the birds through the mountain thickets, and beside which the hunters were accustomed to lie in wait for them, can still be plainly traced. Furthermore, Mr. J. W. Hamilton published, in 1875, in the "Transactions of the New Zealand Institute," his notes of a conversation held in 1844 with an aged Maori, who, as he remembered Cook, must have been then more than seventy-five years old. He had seen a moa, and described it with all the minute precision of personal knowledge. Finally, if these statements should be questioned, we have the decisive fact that the remains of the great feasts of the natives, which have been found in several places, show the bones of the moa mingled with those of the native dog. Now, the New Zealand dog is the Polynesian variety, used only for food; and the traditions of the natives are quite clear as to the fact that their ancestors, when they came to the country some four or five centuries ago, brought the dog with them.

M. de Quatrefages shows, however, that Mr. Haast's opinions have some foundation, though not precisely in the sense intended by him. Of the eleven species of moa, one, and this the largest of all, the Dinornis giganteus, seems to have been extinct before the advent of the Maoris. At least this is the inference which may be drawn from the fact that none of the bones of this species have been found among the remains of their feasts. Of the next in size, the Dinornis robustus, which was but slightly less in stature, the remains have only once been found in this position; and those of the huge Palapteryx ingens have been thus discovered in only three instances. It would seem, therefore, that the largest of these creatures were either extinct or dying out when man appeared on the scene; but this appearance, it must be remembered, was a very recent event. The result is, that Mr. Haast's view can only be sustained by reforming his geologic chronology, or rather nomenclature—at least, for New Zealand—and bringing the Post-pliocene era down to our own times. And this conclusion suggests a consideration of much larger import. If so good a geologist as Mr. Haast has been at fault in regard to the antiquity of the moa, may not other able geologists, who have supposed that the mammoth, the cave-bear, and other extinct animals—the contemporaries of the Cro-Magnon artists who depicted them with such life-like exactness—died out at a period long prior to the historic era, be equally mistaken? There seems no more reason for doubting that the last surviving Elephas primigenius may have been killed by some bold hunters of the Cro-Magnon race, in the time of one of the early Pharaohs, than there is for questioning the fact that the last Dinornis was killed by the Maori hunters in the reign of George III.

GENIUS AND MENTAL DISEASE.

By WILLIAM G. STEVENSON, M. D.

IT were comparatively an easy task to explain psychological phenomena by asserting, as did the metaphysicians of the past, and as some do even at the present, that the human brain—the physical sanctuary of thought—is merely an instrument through which various spiritual beings operate, producing at one time the prophetic utterances of the seer, at another time the gifted words of genius, and yet again the extravagant and discordant expressions of madness. This was the "working hypothesis" of Pagan antiquity in its efforts to explain the utterances of its oracles, and also of the Christian fathers in their attempts to explain the inspiration of the prophets and of the apostles.

Greek supernaturalism and the Christian doctrine of inspiration here found a common point of agreement, for both implied a "divine intoxication"—an "overflowing of the mind"—because of its entire possession by a divine influence, which, according as it was good or evil, excited a "poetic furor" indicative of genius, or caused a wild frenzy which was known as madness.

Genius, therefore, was simply a reflection, through the human brain, of an outside divinity of good; while insanity was merely an expression of satanic possession—an inspiration of an evil spirit—and in nature was closely allied to genius.

This belief, although somewhat modified by filtering through ages of changing thought, has been superseded only in very recent times by the conceptions which reflect the broader generalizations of inductive science. From the data thus furnished comes the conviction that mental phenomena "are dependent upon the properties and molecular activities of nerve-tissue," and that there is a "bond of union" between psychical expressions and a nervous mechanism, although the nature of this union is unknown. The facts of consciousness are marshaled before us with all the force of attested verities, but are yet veiled with all the mystery of a passing dream.

The quality of mind known as genius involves, in connection with the reasoning faculties, the special exercise of imagination in its higher creative or constructive forms; and in understanding this faculty we have an insight into the marvelous nature of genius.

It may be said that imagination is that faculty which, in its lower or constructive form, works within the limits of recollection, and transforms the materials of sense-experience into pictures of thought, and recombines them into forms of greater beauty and usefulness, while in its higher or creative form it distills therefrom truths which reason has not yet discerned, and idealizes beauties and excellences which excite our admiration and exalt our emotions.

When thought symbolizes to the mind "the forms of things unknown," it is because the imagination—leaping beyond the bounds of sensory perception—gathers from the infinitudes of unrevealed realities new truths, and thereby "gives to airy nothing, a local habitation and a name." It is thus that the intellect is able to extend the horizon of knowledge, and obtain material for the workshops of the brain.

Imagination, however bold may be its flight, is, nevertheless, under the restraining influence of reason, and performs its wondrous work along true parallels of thought. Its ideals are not mere symbols of myths and fleeting shadows, but ideals which are the embodiments of eternal truths. Thus, by its sovereignty in realms where Ariadne's thread is lost from view, the imagination constructs its empire, and gives by its own methods new revelations of truth, thereby "converting all nature into the rhetoric of thought."

This, then, is the special mind-quality—the "vision and the faculty divine"—which constitutes the power of genius.

In the attempt, not to define genius, but to explain the order of its succession, Mr. Galton was led to "conclude that each generation has enormous power over the natural gifts of those that follow," and that native endowments of mind are of themselves quite sufficient to enable an individual to become "eminent" or even "illustrious."

That there is a profound principle of truth involved in the question of heredity can not be denied, and that the factor of inheritance is the most essential of any which enters into the complex equation of mind as well as of body, is a well-established fact; but it is not the only factor which determines mental expression, nor can a complete classification of known facts be made from it alone. Heredity explains the existence of a general nervous constitution, a brain-fiber, having definite aptitudes or "organic dispositions," which are transmitted from parent to offspring, securing thereby not only a continuity, but a conservation of psychical as well as of physical properties; but the special way in which this mental aptitude shall show itself is largely dependent upon external influences or an unexplained spontaneity.

Organization limits the influence exerted by environment, while environment limits and modifies the development of the capacities of the organization.

The explanation of genius through the operation of the biologic law of heredity is very satisfactory so long as antecedent and sequence bear to each other definite and ascertainable relations; but trouble begins when the genetic record fails in its apparent unity—as when genius and mediocrity have kinship.

Whence came the genius of Phidias, which enabled him with such immortal art to create in carved ivory and fretted gold the Lemnian statue of the Parthenon and the Zeus of Olympia; whence came the power of Michael Angelo, Salvator Rosa, Leonardo da Vinci, and Rubens, to paint in matchless beauty, on canvas and in fresco, the wondrous imagery of their minds; or of Beethoven, to record in his symphonies the raptures of his soul; or of Scott, to clothe with the habiliments of life the ideals of his brain; or of Spenser, Burns, and Byron, to write with such rhythmic beauty; or of Goethe, to garnish with poetic dress the deep philosophy of his thought? In what cloud-land of the past were hidden the possibilities of Dante and Milton, who made their visions of the eternal realms the subject of impassioned verse—at once gorgeous in its rich tracery of thought, and sublime in its pageantry of bliss and woe? In what ancestral brain did sleep the transcendent genius of Shakespeare that read every page "in Nature's infinite book of secrecy"; or did smolder the giant intellect of Newton, which weighed the planets and bound with the force of gravity atoms and worlds in a bond of unity?

Such examples seem indicative of conditions powerful to modify, transform, or deflect the action of the laws of heredity, and to cause "indefinite variability" in psychological phenomena, as is done in material forms. This variability, this new psychic manifestation, is robed with the insignia of a new creation; a new species has been born into the realm of mind, displaying new and more exalted powers, but nevertheless restrained in its action by the organization which, under law, presides with such tyranny over every mental expression, and makes us, to a greater extent than we commonly think, creatures of an inexorable destiny. The contrast between the exalted ideals and grand achievements of genius, and the feeble, discordant expressions of madness, is as pathetic as it is striking. The citadel of thought has been despoiled of its most precious adornment, and in the place where once the Muses sat, mocking echoes now hold carnival, and "melancholy sits on brood."

To give a definition of insanity which shall prove acceptable to medical psychology and to practical jurisprudence, is a more difficult task than it may appear. This is because of the differences in the appreciation of causes and effects in mental phenomena which exist between minds trained in the technical details of physiological and pathological knowledge, and those who witness merely a few of the more pronounced expressions of lunacy, but are unable to trace the expressions to their relating causes.

To have even a moderate understanding of insanity, it is necessary to clearly comprehend the nature and import of "illusion," "hallucination," and "delusion"—which, when they exist, are of so much importance that some would fain have us believe that the possession of any one of these symptoms is sufficient to make genius and insanity "a little more than kin, and less than kind."

When a person sees, hears, smells, tastes, or feels an object, but perceives it to be what it is not—as when a tree becomes a man, and the murmuring wind his voice—an illusion exists; a real sense-impression is wrongly interpreted by the perceptive centers, and hence the perception does not correspond with the external object.

Hallucination originates within the brain, and is the perception of that which has no real existence; indeed, so purely subjective is it, that the senses have no agency in its production. Under conditions of concentrated attention, ideas, feelings, and sense-perceptions, are marshaled into consciousness with as great distinctness as if they were the products of external objects, rather than that of subjective conditions alone. This comes from the fact that the sense-centers are influenced by impressions received independent of their source. Its function is to transform impressions into conscious sensations, and hence an idea or emotion, when directed in a special way with persistent, concentrated force, may so impress the sensorium as to cause it to project into consciousness sensations which seem to come from objects in the external world. I can not tell how this is done, neither can I tell how it is done when impressions come from without. The facts we know, but the secrets of transformation elude us. The brain constructs new forms, but conceals the methods of imagination by the shadow of unconsciousness.

Ajax becomes enraged because the arms of Achilles are given to Ulysses, and in his wrath he sees animals as Greeks and assails them as if Ulysses and Agamemnon themselves were before him. Talma intensified his emotions and his dramatic effect by the illusive specters of his mind. Spinoza beheld with great distinctness the disagreeable image of his dream a long time after sleep was gone; and Niebuhr, when describing the scenes of his travels, would see all rise before him in "all the coloring, animation, and splendor of Nature." Multitudes have been at times subject to the same false perceptions; as when the soldiers under Constantine saw the cross in the sky bearing the inscribed words, "*In hoc signo vinces*"; or when the army at the battle of Antioch, excited and superstitious, saw the saints—George, Demetrius, and Theodosius—descending through the clouds of heaven to their support.

The consummate skill of Shakespeare in portraying the different phases of false perception, and his power of psychological analysis, are wonderfully illustrated in the dagger-scene of "Macbeth." Intent on murder, with "courage screwed to the sticking-place," Macbeth is about to enter the king's chamber, when he is startled and dismayed by an apparition of a bloody dagger in the air. For a moment he questions the reliability of his sight, and exclaims:

> "Is this a dagger which I see before me,
> The handle towards my hand?"

He can not believe the testimony of his eyes, and therefore seeks confirmation in the sense of touch:

> " . . . Come, let me clutch thee:
> I have thee not, and yet I see thee still."

Failing to grasp the dagger, he wonderingly asks:

> "Art thou not, fatal vision, sensible
> To feeling as to sight?"

And then, as if reason were struggling to gain supremacy over the senses, he continues:

> " . . . or art thou but
> A dagger of the mind, a false creation
> Proceeding from a heat-oppressèd brain?"

How suggestive, how replete with truth was this prophetic utterance; and yet the intensity of his mind's tension—because of the deed to be done and the vision of the instrument for its execution—still makes the terrible idea the dominating factor of his mind, and subordinates the senses to its rule! He is not yet able to entirely dispel the hallucination, and he compares the apparition to the trusted blade at his side:

> "I see thee yet, in form as palpable
> As this which now I draw. . . . I see thee still,
> And on thy blade and dudgeon gouts of blood
> Which was not so before!"

And then, as if the blood upon the dagger had, by its horrid suggestiveness, steadied his brain, Reason once more resumes her seat and denies the apparition, by asserting—

> " . . . There's no such thing;
> It is the bloody business which informs
> Thus to mine eyes."

These false perceptions, these illusions and hallucinations, while they do not necessarily indicate any mental unsoundness, have been, however, the fruitful source of those apparitions, whether of demons, fairies, or ghosts, which have added to the credulity of man, intensified his superstitions, and made possible the organization of human error under such forms of belief as are typically illustrated by witchcraft and spiritualism.

So long as an individual is conscious that the illusions and hallucinations of his senses are unreal—merely "such stuff as dreams are made of"—the intellect is not affected; but when the false perceptions are accepted as realities, the mind itself is then involved, and a delusion or a false belief is said to exist.

A delusion may be based upon false perceptions; faulty ideas from perverted reasoning about real events, or from mental inability to distinguish differences in things.

A false belief is not, however, of itself indicative of insanity, so long as it is in harmony with the individual's common mode of thought and with the spirit of the age. This is apparent when it is remembered that witchcraft—now regarded as a delusion—was, not long since, held to be a truth; indeed, such master-minds as Bacon, Jewel, Luther, Calvin, Wesley, Blackstone, Coke, and Dr. Johnson, in accepting as a truth that which we now know was a mental epidemic of error, reflected only the universal belief of the age, and were free of any taint of insanity.

That the standard of mental health is variable because it is conditioned by race, age, environment, and circumstances, is abundantly attested by the history of the past; and this fact should be recalled in discussing the kinship of genius and madness.

The popular literature relating to genius and insanity is so meager and fragmentary that the recent contributions by Mr. Sully, on "Insanity and Genius" and "Genius and Precocity," and by Miss Sanborn, on the "Vanity and Insanity of Genius," are as welcome as they are interesting. It is obvious, however, that names are often used to show the kinship between insanity and genius which do not represent the most illustrious minds. Mr. Sully is, however, logically correct in thus using names, for he includes under the term genius "all varieties of originative power, whether in art, science, or in practical affairs"; but in so doing he destroys, it seems to me, the value of his argument in support of the relationship of insanity and genius, for, measured by this standard, the evidence is overwhelmingly against the theory. Neither is due regard given to the real significance of false perceptions, which are often made to appear indicative of insanity, when in reality mental integrity is not impaired.

Although obliged to follow a common trend of thought with familiar illustrations, it is, nevertheless, my hope to place a few garlands of honor on the brow of Health, and to defend genius against the implication that it exists only with madness. The profound ignorance of the ancient philosophers concerning the nature of mind itself justifies us in attaching but little importance to their interpretation of its phenomena.

Thus, Plato's "Psychology" affirmed a self-existent, self-moving, and eternal soul, in form "like a pair of winged steeds. . . . In divine souls both steeds are good, in human souls one is bad. . . . Before entering the body the wings are lost which were nourished by beauty, wisdom, goodness, and all that is divine. . . . The mind of the philosopher alone has wings; he is ever initiated into perfect mysteries, and his soul alone becomes complete. But the vulgar deem him mad and rebuke him; they do not see that he is inspired. This divine madness is kindled through the renewed vision of beauty. . . . Love itself is madness."

The soothsayers, or diviners, to whom Plato ascribed the "nobler madness," were regarded mad, not only because of their wisdom, but because of their extravagant rage and noisy behavior.

Virgil describes the inspired priestess as full of enthusiastic rage, and fiercely raving in her struggle to disburden her soul of the influence of the mighty god. Indeed, raging, foaming, and yelling, accompanied with antic motions, was the usual way of expressing the influence of inspiration or "possession."

Since Aristotle held psychological views similar to those of Plato, his saying that "it is the essence of a great poet to be mad" adds nothing to the strength of the theory.

The "madness," referred to in the conversation between Horace and Damasippus, did not specially relate to intellectual conditions, or to what we know as insanity, as has been intimated, but rather to individual and social ethics. The "Satire" says: "The school and sect of Chrysippus deem every man mad whom vicious folly or whomsoever the ignorance of any truth drives blindly on. This definition takes in whole nations; this even great kings; the wise man alone being excepted. . . . Whoever is afflicted with evil ambition or the love of money; whoever is smitten with luxury, or gloomy superstition, or any other disease of the mind, . . . come near me, in order, while I convince you that you are mad. . . . Whoever shall form images foreign from truth, and be confused in the tumult of impiety, will always be reckoned disturbed in mind; . . . where there is foolish depravity, there will be the height of madness. He who is wicked will be frantic too."

I confess that, with such statements before us, it hardly seems necessary to discuss the value of ancient opinions on a subject which must be treated under the restrictions of modern definitions. We will, therefore, examine the question from the standpoint of more modern times, when the supernatural agency in insanity gives place to the deteriorating influences which unite it to other forms of nervous disease; and genius becomes a product of an age, in the expansive growth of the human mind.

That these extreme forms of mental expression are often associated, there is no doubt; and that genius is, at times, shadowed by mental disease is a fact well known; but our interest centers in the inquiry, whether this relationship is such an essential one as to justify Dryden in asserting—

> "Great wits are sure to madness near allied,
> And thin partitions do their bounds divide."

Or Shakespeare, when he says:

> "The lunatic, the lover, and the poet
> Are of imagination all compact."

In support of this essential union, Montaigne, Diderot, Pascal, Lamartine, and others, have subscribed their names, but in terms more general than specific, and with more rhetorical beauty than philosophic strength; while Moreau boldly affirms that genius is a nervous disease.

Charles Lamb, himself at times oppressed with mental gloom, stands almost alone in defense of "the sanity of true genius." With this view I am in accord, and, that the justification of this position may be seen, I desire to review the facts commonly cited against it.

Sophocles—poet, statesman, commander—was obliged to make a defense against the charge of insanity, instituted by ungrateful and avaricious children. He answered by reciting the tragedy of "Œdipus at Colonos," which he had just finished, and he then asked the judges if the author of such a work could be regarded as mad. The reply was, "No!" and he was acquitted.

Lucretius—"writer of the purest Latin, and author of 'De Rerum Natura,' the most exalted poem of the age"—whose mind combined the "contemplative enthusiasm of a philosopher, the earnest purpose of a reformer and moral teacher, and the profound pathos and sense of beauty of a great poet," has been used to illustrate the kinship of genius and madness upon the unreliable evidence that he lost his reason from the effect of a "love-philter" (a very ridiculous absurdity) which had been given to him; and after writing several books, during his lucid intervals, he committed suicide.

Were this allegation true, it could only show the baneful effect of a drug upon his brain, which is quite apart from the influence of any psychic cause. The historic facts are too few and insufficient to justify any statement as to the life and personal character of this man, who exerted such an influence over others by his writings, and yet, like Homer, was content to let his personality "pass through life unnoticed." Cæsar, Catullus, and Cicero were his contemporaries, and yet we know of him only through a brief record given by Jerome four hundred years after the poet's death. Independent of the historic doubts as to his insanity, the theory which makes a drug its potent cause, should at least find reason for not uniting to it his genius.

That Socrates had his "demon," or guardian angel, may be true; but, if so, the hallucination corresponded with the accepted belief of the age, and therefore signifies nothing against his mental integrity.

Neither is there justification in using such illustrious names as Descartes, Newton, and Goethe, to prove that madness holds its court so near the temple of greatness.

It is true that Descartes, in an hour of deep intellectual abstraction, was "filled with enthusiasm, and discovered the foundations of a marvelous science"; and, it may be that, during his profound meditations, in which he "turned the eye of reason inward upon itself, and tried to measure the value of his own beliefs," an idea became so dominant that the sense of hearing responded to its impression, as if a voice from without had called him "to pursue the truth." In no way, however, did this simple and momentary hallucination interrupt the great work of his life, and in no lawful way can it be interpreted as an expression of a morbid mind.

That Goethe once saw his own counterpart approach him I doubt not, but that this false perception, this passing incongruity—a mere incident of poetic revery when the mind, self-absorbed, wandered in its fancy—should be classed as evidence of a pathological condition, and made to bear witness against the healthfulness of Goethe's mind, is an assumption extravagant and absurd.

That Newton was once "decidedly insane," as some allege, is doubtful; and that he ever suffered from any mental disturbance which justifies the inference that his genius was allied to madness, I hesitate not to deny. Mr. Sully says, "The story of Newton's madness, which is given by a French biographer, and which is ably refuted by Sir David Brewster, may owe much of its piquancy to what may be called the unconscious inventiveness of prejudice."

The facts, as I gather them, point to a congestion of the brain—which culminated in a brain-fever—the result of overwork under unfavorable hygienic conditions. Newton himself refers to his illness in a letter to Mr. Pepys, and again in a letter to Locke, wherein he mentions his loss of memory, and his sleepless nights. It is not strange that his illness should excite the fears of his friends, not only for his physical but for his future mental health. Mr. Pepys expressed his anxiety to Mr. Millington, who replied that he had recently seen Newton, who was then well, and that, although his illness had caused "some small degree of melancholy, there is no reason to suspect it hath at all touched his understanding." Huygens, a contemporary scientist, says, in a letter to Leibnitz in 1694, that Newton was ill for about eighteen months with phrenitis or brain-fever, from which he recovered by the use of medicines. With these data before us, it is a misconception of physiological and pathological facts to assert that Newton was insane; and that there was a kinship between his mighty genius and madness, is contradicted by the intellectual work which has given immortality to his name.

The star seen by Napoleon, which was to him an omen of success; the vision which came to Cromwell, and spoke the words prophetic of his greatness; the apparition which uttered the ominous words to Brutus—"I am thy evil genius, thou wilt meet me at Phillipi!" the dreams and visions of Benvenuto Cellini; the "trees like men walking," as seen by Sir Joshua Reynolds, and the appearance of the devil to Luther—are all examples of hallucinations which are entirely consistent with reason, and are not justly indicative of insanity or mental disease. They represent a habit of mind which naturally, under conditions of concentrated attention, intensified in an age tolerant of all forms of superstitions, "seeks for and creates, if need be, with or without consciousness, an outward object as the cause of its feelings." Luther, for example, saw with his "mind's eye" the image of the devil, which, in that age of religious excitement and credulity, was ever expectant in all minds, and generally present everywhere. "Hallucinations were," says De Boismont, "in the whole social community, not in individuals"; and hence it was that under the dominion of a general belief, however vague or irrational it may have been, the individual mind "demanded of imagination the realization of the phantasms of its dreams; and imagination, despite of the resistance of reason, endowed them with form and substance." Herein is found a distinguishing factor "between real insanity and the separate phenomena of genius and moral exaltation."

In further support of this opinion we may cite the hallucinations of Loyola, when he heard celestial voices; of Edward Irving, who received the gift of prophecy and the "power of tongues"; of Dr. Johnson, when the voice of his dead mother came to him; of Malebranche, when the deep feelings of his soul were to him the audible voice of Deity, and of Joan of Arc, who, under the guidance of saints, led the French arms to victory.

That genius "has its roots in a nervous organization of exceptional delicacy," is undoubtedly true, but it does not necessarily follow that the liability to mental discord and confusion is thereby increased, because this delicacy of brain-structure and its functions are admirably adjusted, and the very perfection of the mechanism enables it to work with the least possible friction or injury.

Under certain conditions, however, we have eccentricities of thought, feeling, and action, which indicate an unstable condition of nerve-element; but it does not follow that this instability necessarily impairs the integrity of the mind; much less does it imply that "genius," more than the lower expressions of mental power, is nearer the border-land of mental disease. I doubt not that permutations of this unstable condition may occur which, by supplementing the natural gifts of mind, cause a variety of individual traits. It may give to the poet Campbell indecision and indolence; make Carlyle cross and pessimistic; Byron proud, generous, and reckless; Schlegel foppish in his vanity; Keats despondent; Pope crafty and pretentious; Swift satirical, avaricious, and irascible; Chateaubriand egotistic and vain; Burns and Poe convivial and intemperate; Eliot sensitive and dependent; Hawthorne shy and modest; Wordsworth simple-hearted yet full of conceit; and Ampère absent-minded and unpractical. Thus might I show certain peculiarities which belong to the personal mental outfit of almost every one whose individuality is sufficiently marked to make him worthy of notice; but these peculiarities or eccentricities are not essentially morbid, neither do they give affirmative evidence that genius is related to madness. Such peculiarities belong to all orders of mind—the humble as well as the exalted—and can not, therefore, have an exclusive application.

Add to the personal eccentricities of Pope, Byron, Johnson, Carlyle, and Swift the temper which at times became in them extravagant rage, and the proof is yet no stronger that genius and insanity are but different types of mental disease; for passion and appetite are, in all their forms, expressions of organic life and common to humanity, and therefore, as universal factors, they can not be dissociated and made to bear witness either for or against the subject before us. It has already been admitted that eccentricities of character imply a want of mental poise or equilibrium, which is even more apparent in the extravagant passions which at times hold individuals under despotic control, and often indicate decided moral obliquity. This I do not deny, but yet affirm that the violent passion at times observed in one of exalted powers of mind is no more evidence in favor of the kinship between these powers and mental disease, than is the same passion, when displayed in a low and vulgar mind, proof that stupidity is a congener of madness. Mr. Madden is quite as justified in asserting that "the maladies of genius have their main source in dyspepsia," or I in affirming that, because some eminent men have been physically puny and ill-formed, therefore their genius is related to, and dependent upon, bodily imperfections.

In trying to establish the kinship between mental greatness and disease, Mr. Sully states, what I do not deny, that "a number of great men have died from disease of the nerve-centers," naming Pascal, Cuvier, Mendelssohn, Mozart, and Heine—none of whom, however, were insane.

That genius should be subject to "all the ills that flesh is heir to" challenges neither surprise nor dissent; but to hold this as evidence in support of the idea that "the extreme mind is near to extreme madness" is, as it seems to me, an erroneous interpretation of physiological and pathological facts. To prove that Pascal died in convulsions from an acute brain trouble, in connection with a disease of bodily organs, and that Mendelssohn and Rousseau died of apoplexy, and Heine of spinal disease, is not proof that there was any essential weakness or disease of nerve-element, but rather is it evidence of disease of blood-vessels through faulty nutrition. When hæmorrhage occurs in the brain, its substance is disorganized, as it might be if any other foreign substance were forced into it, and nervous disturbance very naturally follows; and possibly secondary nervous or mental disease, but it is not correct to speak of the primary apoplexy as a disease of the brain, or to infer that, because a person of high mental endowments has thus suffered, therefore, as Lamartine says, "Genius bears within itself a principle of destruction, of death, of madness." Cuvier, after a life of incessant intellectual toil, with mind unclouded, died at the age of sixty-three, from paralysis of the throat and lungs. Kepler, sound in mind, died when sixty years old of fever, which some say caused an abscess in the brain. The cause of Mozart's death is unknown; his sickness was of short duration. He thought himself poisoned, but the facts were hidden in the pauper-grave wherein his body was unkindly thrown. Now, I protest that such cases give no evidence of insane temperament, and in no way illustrate the kinship between mental greatness and disease.

Again, it is said, and often with reason, that this kinship is shown by the suicidal impulse, which "is only another phase of insanity." That suicide or homicide may result, under this impulse, I doubt not, but to make this fact of special value its numerical proportions should at least be such as to make it a factor of constant value. Because Goethe, Chateaubriand, George Sand, and Johnson have said that at times they felt an impulse to commit suicide; because Beethoven, Schumann, and Cowper, who were at times morbid, really made the attempt; and Kleist, Beneke, and Chatterton succeeded in self-destruction—we are not justified in saying that the impulse or the act itself came because genius contains an element of madness. Hundreds who commit suicide every year do not possess genius; why, then, make it the responsible agent for the few?

It is charitable to think that the misdeeds of our friends, or of those whom we admire, are covered by the plea of irresponsibility through insanity. Science, however, deals with facts, not sentiments. That mental and motor impulses often occur which, because they are stronger than volition, regard not the consciousness of right or wrong, there is no doubt; that these impulses are very frequently the product of a morbid mind is also well attested, but the question before us is limited to the relationship which genius bears to suicide, as one expression of madness.

I confess I can see only that relationship which exists in the organic necessities which constitute the foundation of human thought and action, and not the psychological relationship which makes the exaltation of mind the destroyer of its life.

The regularity and constancy of results which spring from the varying conditions of race, climate, and occupations, as well as from the social, political, and moral influences around us, clearly indicate, what statistics prove, that madness is but one of many causes of suicide. Now, since genius is itself exceedingly rare, and its union with insanity still less frequently found, it is evident that suicide, although occasionally committed by those of exalted minds, is altogether too infrequent among them to justify us in claiming it as evidence in behalf of the insanity of genius. Certainly, when we find that Kleist, Beneke, and Chatterton stand almost alone in this list, the support for the assumption is not strong, nor is it enhanced if the quality of genius thus represented is duly estimated.

Those who would make genius dependent upon or associated with a morbid mental state, seek to strengthen their position by citing the names of Burke, Chatham, Linnæus, Moore, Southey, Scott, Swift, and Shelley, as among those whose faculties were impaired by mental disease. I interpret the facts differently.

It is true that Linnæus at the age of sixty failed in memory, and that, when nearly seventy, an attack of apoplexy ruined his mind; that Moore, Southey, and Scott, when the years of their life were nearly numbered, were enfeebled in mind, because in old age the work of repair had failed; while Swift, at threescore years and ten, lost his mental powers as a result of a disease which began long years before, not in the brain, but in the organ of hearing.

Shelley, indeed, was eccentric and given to sleep-walking and hallucinations, and at times he may have confounded the mythical with the real, seeing "forms more real than living man," but I know of no rule of psychology or of medical jurisprudence which will authorize us to say he was insane. His fervor, his reason, and his imagination conspired to lift him into the higher realms of an idealism which was the antithesis of things as commonly seen, and his mind grew and strengthened until, at the age of thirty years, obedient to the "infinite malice of destiny," he died.

Because Lord Chatham suffered at one time from melancholy, the direct result of suppressed gout, it in no way proves that his genius was allied with madness, for the same clinical facts are observed in all orders of mind.

Since, therefore, every degree of mental disorder from the simplest feeling of depression to the wildest mania, regardless of the quality of mind, may follow from the undue retention in the blood of the waste products of tissue-change, either alone or combined with other morbid bodily conditions, there seems to be but little justification in asserting that "there is no great genius without a mixture of insanity."

In the history of political literature the name of Edmund Burke stands among the first, and is representative not only of that illuminating power which belongs to lofty minds, but of the genius which comes "as the consummation of the faculty of taking pains." Year after year his voice sounded in behalf of the "sacredness of law, the freedom of nations, the justice of rulers," and the imagery of his thought—imposing in its majesty—"carries us into regions of enduring wisdom." For nearly threescore years his mind retained the dignity and calm of lofty greatness, and seemed to totter from its balance only when he breathed the torrid heat of fury which was sweeping over France and gathering wrath against the horrid atrocities of "'89." He had before him the vision of Marie Antoinette, "glittering like the morning star, full of life and splendor and joy," and felt that, through unbelief and passion, the props of stable government and morals were being broken and destroyed. The "divine right of kings" was yet an article of common faith, and he saw their sorrow, but heard not the wail of anguish which ascended from the oppressed and starving people. Rage against the lawless Parisian mob filled him, and in his wrath he spoke as if envenomed hate had made him mad; and he was so adjudged, but only by those who differed from him. The inspiration of his genius gave him the tongue of truth, and the penalty was an assault upon his sanity.

Then came the supreme sorrow of his life, the death of his son, and in his grief he wrote: "The storm has gone over me, and I lie like one of those old oaks which the late hurricane has scattered about me; I am stripped of my honors; I am torn up by the roots, and lie prostrate on the earth. I am alone, I have none to meet my enemies in the gate; . . . I live in an inverted order. They who ought to have succeeded me have gone before me. They who should have been to me as posterity are in the place of ancestors."

Because of the outward expressions of grief which were at times his, as when his son's favorite horse came to him and put its head upon his bosom, which caused Burke to cry aloud in his sorrow—because of such manifestations of grief, it is said Burke was mad. Edward Everett has well said: "If I were called upon to designate the event or the period in Burke's life that would best sustain a charge of insanity, it would not be when, in a gush of the holiest and purest feeling that ever stirred the human heart, he wept aloud on the neck of his dead son's favorite horse." As proof that his intellect was not disordered, his "Letters on a Regicide Peace," written in 1796, a year before his death, bear ample evidence, and are regarded, says John Morley, "in some respects the most splendid of all his compositions. . . . We hardly know where else to look either in Burke's own writings or elsewhere for such an exhibition of the rhetorical resources of our language."

That Burke had at times eccentricities and fleeting aberrations may be true, but to call such a man insane, or to speak of him as illustrative of the kinship between genius and madness, is to make sport of facts and mockery of human thought.

Notwithstanding the many names I thus take from the roll-call of madness, there are, nevertheless, many gifted minds that have not been absolved from this sad heritage, or been able to bear with calm serenity the misfortunes and burdens of a weary life. Such was Schumann, the eminent composer of music; and Blake, to whom the realities of the world were but dissolving forms of his own consciousness; and Clare, who, when his melancholy was deepened by the neglect of family and friends, wrote so plaintively of his own gloom and loneliness. Cowper was timid and morbid, and agonized under religious melancholy and suicidal impulse. The insane temperament was also definitely marked in Comte, the oracle of the "Positive Philosophy"; in Tasso, whose melancholy fate gave to Goethe the opportunity to picture a psychological drama, wherein character is revealed under the glow of "poetic furor," and also, at times, oppressed by morbid fears and delusive visions; in Swedenborg, whose prolific mind teemed with fancies and speculations, contradictions and absurdities, which can only be explained on the theory of a mind diseased; and in Charles Lamb, whose "diluted insanity" cast an enduring shadow over his life.

The facts, as I view them, make me dissent from the theory that a diseased brain is the physical substratum of genius, or that the possession of such exalted mental endowments "carries with it special liabilities to the action of the strong disintegrating forces which environ us." "A large genius," says Dr. Maudsley, "is plainly not in the least akin to madness; but between these widely separated conditions a series of connections is made by persons who stand out from the throng of men by the possession of special talents in particular lines of development; and it is they who, displaying a mixture of madness and genius at the same time, have given rise to the opinion that great wit is allied to madness."

To the extent that a nervous organization makes possible excessive emotional life, or vagaries in thought or action, to this same extent is true genius qualified and limited; for, without calm reason and volitional control, creative imagination is distorted into an irresponsible fancy.

The degree of perfection of any mechanism, whether it be a watch, an engine, a harp, a telescope, or the human brain, is the measure of the quality of the work which can be produced therefrom; and, conversely, the quality of the work is an index of the structural character of the instrument employed.

The better the finish and adjustment of a mechanism in its various parts, the less will be the friction, and the "wear and tear" from constant use; and, although the very delicacy of its adjustment may give a greater susceptibility to disturbing causes, the causes themselves are not inherent but incidental. These facts apply with equal force to that most perfect and complex of all known mechanisms—the human brain, which is energized with the subtile principle of life, and evolves thought, feeling, and will, which, in their noblest and most exalted expressions, are indicative not of disease but of mental health.

Nervous and mental diseases are too common among all classes of people, and orders of intelligence to permit us to think that genius is the special object of their dominion. This idea is rejected, not because it is repugnant, but because it is not sustained by facts when measured by the standard of the highest art, or loftiest thought, or greatest work.

Look at the scores of eminent names within a hundred years, and show therefrom, if possible, the evidence which justifies the statement that intellectual greatness is "beset with mental and moral infirmity," or that genius is merely an expression of a morbid mind, akin to madness.

Imagination gives to genius—which is the intellectual scout of progress, and the Titan force which organizes the factors of civilization—a realm wherein the soul throbs and burns with the fervor which comes only when a new truth cleaves the darkness and illumines a pathway hitherto unrevealed; and where the clash and turmoil of cerebral action excite the highest pleasure, though at the same time they often weary and exhaust.

In this century, when the fierce blaze of modern thought has filled the world with unparalleled glory, and the inventive genius of man has made the earth a vast workshop of industrial arts, wherein the human brain is "master-workman" over all, how rare is it that the brain-worker feels the oppression of a "mind diseased," except when, like the wage-worker, he frets and worries under the burdens of a weary life, and falls by the wayside because the struggle for existence—keen, sharp, and relentless—has taken from him the inspiration, the strength of hope!

Mental stagnation, personal or domestic sorrow, social inthrallment, religious excitement, crushed hopes, and poverty, are the chief moral causes which contribute so largely to the mental infirmities of man.

In conclusion, I hesitate not to say that the most illustrious names of ancient or modern times—in all departments of human thought or activity—have been, with but few exceptions, loyal to the sovereign rule of sane reason; and the sweep of their imagination has been in curves which rounded in the bright empyrean of truth and beauty.

ANIMAL-PLANTS AND PLANT-ANIMALS.

By Dr. PFUHL.

If we examine the bright bow of Iris painted on the heavens by the sunbeams that break through the parting storm-clouds, no matter how closely we may scan it, we shall not be able to determine where the colors begin or end. As in this arch the blue gradually passes over into a green, and the green in turn changes insensibly into a yellow, even thus we find, in the countless forms in which Nature delights, the most delicate gradations, the most gradual transitions. *Natura non facit saltus:* this saying of Linné's is realized everywhere in the ever-changeful realm of life.

How difficult a matter it is to decide whether the lung-fish of Brazil and Senegambia belong to the amphibia or to the fishes, which in other instances are known to always breathe by their gills! In the rainless season of the year the swamps, the homes of these animals, dry out; they then coat themselves with a crust of earth, and are dependent on their lungs for every breath they draw. During the rest of the year they can use either these or their gills.

The close relation between fish and amphibia is established in yet another way by the Caudata, which retains its gills and does not lose them, as do its relatives, the frog and salamander. The olm of the Adelsberg grottoes also belongs to this class; it is an animal of a pale-red color, which spends its existence in subterranean darkness. Its eyes, as is also the case with other animals that live in constant darkness, are not developed, there being no possible use to which they could be put; they are very small, and lie beneath the skin.

A connecting link between the birds and the reptiles is found in the fossil archæopteryx brought to light in the slate-quarries at Solnhofen; the feathers denote a bird, the rest of the body is that of a reptile. The *Ornithorhynchus paradoxus* of Australia serves to connect the feathered tribe with the mammalia. It lives in seclusion in dreary regions on river-banks, and builds its subterranean home in such a manner that one of the two exits is always submerged by the stream. It has four feet, and a broad bill, with horn plates on the edges like that of the duck, and seeks its food like this fowl. At the foot of the male there is a spur corresponding to that of a rooster; between the toes are webs like those of water-fowl. It would hardly seem surprising to find this strange creature, in many respects so like the birds, propagating its kind by eggs; but it is a true mammal, and gives birth to live young.

The transition from the palms of the tropics to the palms of the north—the fir-trees—is made by the shining cycadees, whose leaves, as emblems of peace, are placed on tombs. The guetacea must also be regarded as intermediate between the lower and the higher orders of plants. To these belongs the curious "welwitschia" of Africa, the thickness of whose stem exceeds by three times the height. During its whole life—over a century in duration—it bears only two, but very large, leaves, fully two metres in length and one metre broad; it is well named "the wonderful."

At first sight the assertion may seem strange, that the dividing line between the animal and the vegetable kingdom is not definite, and that one may sometimes be in a quandary to know whether he is dealing with an animal or a plant. That the rose must be accounted a plant there can be no doubt; and that the gaudy butterfly, coyly hovering above it, must be classed with the animal kingdom, remains unquestioned. But it is by no means so easy a matter to determine the nature of that peculiar being which we find in damp moss. It is a slimy mass, but little colored; it moves slowly and in every direction, yet no feet are discernible. After a long dispute the botanists have had to accept into their realm these slime-fungi, for during a part of their existence they are distinctively plants, and propagate by spores.

Since the oldest times attempts have been made to find some features characteristic respectively of animals and of plants. But all of these criterions, one by one, have had to be abandoned. Finally, Haeckel, of Jena, severed the Gordian knot. He created an intermediate realm to which all is consigned that is not distinctively a plant or an animal. Now, however, the difficulty is only greater than it was before. Formerly the question was, Animal or vegetable kingdom? Now it has become, Animal, protista (for thus Haeckel named this new division), or vegetable kingdom?

This system of classification at least affords us a general view over those organisms which are, as it were, the connecting links between the vegetable and the animal world, between which, at first sight, there seems to be an impassable chasm.

The slime-fungi have before been alluded to; the class of fungi embraces yet other groups that, as animal-plants, call for some notice on our part. Above all must be named the bacteria; in 1853 these organisms were relegated to the vegetable kingdom. In the case of many bacteria, motion can be observed; some move quietly about, others slide and glide to and fro like snakes or eels. A few species are provided with special thread-like filaments for this purpose. Some bacteria, as well as many other kinds of organisms, can withstand—that is to say, survive—considerable heat. There are, for instance, the algæ in the waters of the Carlsbad Sprudel; they attain luxuriant growth at a temperature of 54° C. Other species of this kind live though exposed to the hot vapors (about 65° C.) of Ischia and Liparia. This is all the more remarkable as protoplasm, the albuminoid substance on which the phenomena of life depend, curdles at a much lower temperature.

A similar tenacity of life has been observed also in plants of a higher order. Wheat-kernels, for instance, if they have been previously well dried, lose the property of germinating only at 72° C., barley at 65° C.; if moist, however, they die at a temperature of about 50° C. The seeds of many leguminous plants can not survive a temperature of 35° C. Pouchet, however, has observed that seeds which were found in the unwashed wool of Brazil sheep resisted for four hours the action of boiling water. The hard seed-shells had prevented the entering of the water. Haberlandt in 1863 made experiments with the seeds of eighty-eight different kinds of cultivated plants, and found that some of them could, when in a perfectly dry condition, stand, for forty-eight hours, exposure to a temperature of 100° C.; in some instances, in fact, germination was hastened by the higher temperature. Nor is the power of germination always destroyed by intense cold. This is demonstrated by the fact that, of three hundred wheat-kernels which were left north by the Polaris in 1871, some sixty germinated in 1877.

Let us now turn our attention to a different group of organisms, before briefly referred to, and which formerly were regarded as belonging to the animal kingdom—some species of algæ.

In 1843 the botanist Unger, while examining certain green plant-fibers under the microscope, suddenly noticed some sphere-like bodies dart out of these fibers and move to and fro in the water, kept in rapid motion through the aid of cilia.

This wonderful sight (for up to this time nothing like it had been observed) surprised him greatly, and he announced his discovery to his collaborators in an essay bearing the title, "The Plant in the Act of Transformation into an Animal."

To the algæ belong those minute organisms that sometimes give to water a bluish-green color, that redden snow, and that change ordinary rain into a rain of "blood." Ehrenberg states that the Red Sea takes its name from the algæ which it sometimes throws far up on its shores. Reports of "blood-rains" are not at all infrequent in the records of the past. Chinese history, written eleven hundred and fifty-four years before the Christian era, makes mention of such a phenomenon; the Bible writers speak of similar occurrences, and Livy also reports an event of this kind.

But only one group of these organisms, the diatoms, will receive our closer attention. They surpass the bacteria in size; still, a good microscope is needed to observe them. Whereas the bacteria present only few, and at that, simple forms, but colors of varied hue, the reverse is true of the diatom family. Their color, when they possess any, is a more or less dark brown or a green, but the delicacy and beauty of their forms is striking. Some look like minute gondolas, others resemble fans, or approach in form an S, a circle, or an ellipse. If a higher magnifying power be employed, most dainty linear tracings will be seen on their shells, for these beings are enveloped in shells which consist chiefly of silica.

Linné's expression, "*Natura in minimis maxima*" (with her smallest agents Nature accomplishes her greatest works), is especially borne out by the diatoms, for they have been active agents in the formation of the crust of our globe; rocks, ocean-beds, in short, entire geological formations, are the results of their labors. The polishing-slate of Bilin consists only of diatoms—one litre containing something like two billions of them. A considerable part of Berlin, the capital of the German Empire, is built upon a bed of diatoms, the uppermost layer of which is still alive.

Thus far we have noticed the power of locomotion—this prime characteristic of animal life—only in the lower orders of plants, the algæ and fungi. Might we not expect to meet with this also in plants of a higher order? Motion, perfectly free and unrestrained, we should here of course seek in vain, but many plants possess the power of moving some of their parts. In this connection we would recall the Mimosa, which, in response to the slightest touch, will immediately fold her leaflets. This same effect is also induced by cold and darkness.

The flowers of many plants are found in certain ways to be greatly dependent on temperature and on light. They open in the morning when the sun has reached a certain place in the heavens, and close again at a stated time at night.

Some plants can open their flowers or parts of them very quickly. For instance, the *Martha* of the tropics, on the approach of an insect, ejects its pollen suddenly, and then as quickly closes the entrance to the flower, and refuses the insect admission. Motion of a different nature is shown by the climbing plants that were so closely studied by Darwin.

At times one hears or reads of the wandering of plants. But how is it possible that firmly rooted plants should be capable of changing their position? And yet this is so. In most cases, it is true, the removals are made merely by the seeds and not by the plant as a whole. Sometimes, however, the whole plant starts out to travel; this is generally accomplished by the friendly aid of the wind. The world-famed Anastatica, the rose of Jericho, comes in for mention here. It has the peculiar property of spreading out its branches, that at other times are folded to a ball, whenever its roots are moistened by water. In its dreary home, the deserts surrounding the Red Sea, it is but slightly fastened in the loose sand. Without much trouble it is torn from its bed by the winds and borne to great distances.

Some species of algæ, which form green or yellowish-green masses on the surface of placid waters, are thrown on the land by inundations, and are kept back after the waters have subsided, and finally dry into a peculiar matted substance not unlike coarse packing-paper. This is taken up by a strong wind and carried away. These wandering masses, which some people have readily connected with superstitious conceptions, are called "meteor paper." The water-pest is another plant that spreads itself in the same manner; as far as can be ascertained, it was transplanted in 1835 from North America to Ireland, and from there to the European Continent.

The majority of plants, however, are spread by the aid of their seeds, which are covered with hair or a fine woolen fiber, and can thus be easily scattered about by the winds, just as some varieties of spiders, in spring and autumn time, clinging to a silken thread, intrust to the winds the choice of their future home.

Let us now turn to a group of plants which claim interest by being possessed of a faculty generally attributed to animals only. Not satisfied with the nourishment which the humidity of the soil and the atmosphere afford, they seek to obtain a kind of food which Nature has, strictly speaking, denied them. I mean the *insect-eating plants*.

The knowledge of the existence of these curious beings is not really of a recent date, but former investigations remained unheeded.

Only after Darwin had made his researches were they recalled, and at once commanded the interest of naturalists to such a degree that, at present, there are known over three hundred plants that feed on insects. They belong to various families, and are found in all parts of the globe. But how can the firmly rooted plant capture and grasp the light-winged insect; how can it retain the same sufficiently long to let the digestive juices act upon it? Naturally, in many cases, the sticky substance which is secreted by the leaves is the active agent, as, for instance, one may observe small animals adhering to the resinous stem of the "flytrap." But many plants are provided with special organs for this purpose, and they are able to catch the most nimble of insects with ease and dispatch.

One of the best known of these insect-eating plants found here, as well as in Lapland and Scandinavia, is the Sun-dew (*Drosera*), discovered about a century ago. Another plant, the so-called *Flytrap of Venus* (*Dionæa*) of America, which was brought to England one hundred and twenty years ago, has received the name of Venus for the reason that, like the goddess of Beauty, it attracts and captivates everything that heedlessly approaches it. At the bottom of the plant the leaves cluster like a rosette; from the center of this arises the flower-stalk. The edge of the leaf, which is nearly circular, is overgrown with strong bristles, while its surface is covered with small glands, at either side of which are three long hairs. A fly approaches; carelessly it settles on the leaf, and perchance touches one of the six long hairs: suddenly the leaf folds, the bristles interlace, and the insect is caught. Oftentimes the whole tragedy takes but ten seconds. The sensitive hairs have performed their duty; now begins the work of the glands. These discharge a large quantity of a colorless acid slime—the digestive fluid, pepsin—and the closed leaf changes at once into a stomachic organ. After a lapse of eight or nine days the leaf reopens, the insect has disappeared, the prey has been consumed. The above-mentioned facts constitute the main features of the process of digestion, but in connection with it many questions arise. What happens, for instance, if a non-edible object irritate the hairs, perhaps a stone or a piece of wood? The leaf closes with the greatest possible swiftness, but soon discovers its mistake, and does not discharge the digestive juice; after a lapse of twenty-four hours it again unfolds, ready for another capture. This does away with the marks of distinction thus far generally accepted, namely, that "plants live, animals live and feel" (*plantæ vivunt, animalia vivunt et sentiunt*), for the Dionæa distinguishes quite readily, by taste and feeling, that which is digestible from that which is not. By experiment, it has been ascertained that nitrogenous nourishment is preferred by the Dionæa; hence every kind of meat (beef, pork, and veal, either raw, fried, or stewed) is digested by the plant; also albumen and cheese; the latter, however, causes disturbances during digestion, and the leaf easily ails. If nourishment be again offered to the same leaf, will it be able to digest a second time? Yes; but the process of digestion is much more tardy, and, if the plant outlive this exertion, it certainly perishes in making a third or fourth attempt. Too large a quantity of food will kill the plant immediately. This property, apparently so startling a one in plants—namely, their being capable of digesting animal food—loses in strangeness if we look about us more carefully in the vegetable kingdom. There we find not unfrequently this power of digesting nitrogenous—i. e., animal substances, or at least of changing them from a solid to a more soluble condition. For instance, the seeds of many plants store up food for the purpose of nourishing the young plant in the beginning of its existence. Albumen, a substance particularly rich in nitrogen, is first changed into soluble material by the young bud, and is then by degrees absorbed, or, in other words, digested. Other plants possess similar dissolving juices, but up to the present it has not been ascertained what advantages the plant derives from their possession.

Five grammes of the milk-juice of the fig, diluted with sixty grammes of water, will dissolve ten grammes of fibrin in twelve hours, and in a month's time can gradually digest as much as ninety grammes. In this respect the "melon-tree" (*Carica papaya*), a small tree of South America, has, above all others, claimed the attention of botanists. A few drops of the milk-juice, which fills all parts of this tree, are said to soften in a short time the meat of even old animals, and if we may credit the tales some travelers tell, it is sufficient to roll the meat up in these leaves for several hours to render it soft and palatable. From the milk-juice of the *Carica* there has been obtained a compact substance called "papaiine," three grammes of which will dissolve one hundred grammes of fibrin in two days, and it has furthermore been found that the action can be made a continuous one.

Let us now leave the domain of plants and enter into that of animals, so much more varied in number and form. We shall still fancy ourselves in the kingdom of flowers when we turn our attention to those variegated beings which cluster about the subaqueous rocks in wild profusion. There seem to be brilliant flower-calyxes of hyacinths, carnations, anemones, gently rocked to and fro by the water—calyxes which, even had they grown under the genial warmth of sunlight, could hardly bloom more beautifully. But should one try to gather a bouquet from among these magic flower-beds, he would scarcely have touched a bud, when a sharp, stinging pain, more disagreeable than the burning of the nettle, would be felt. Even the sea-rose defends itself, and stings; very quickly it sends forth from their resting-place filaments charged with a corrosive fluid, filaments that, until then, had remained spirally incased like a spring wound up and ready for use. And how enormous is the number of these weapons of defense; some individuals are capable of sending forth six thousand millions! In the last century the plant-like nature of these sea-flowers was so generally accepted that Réaumur, in the Academy of Sciences, did not disclose the name of Peysonnell, a physician of Marseilles, who first declared them to be animals, for fear of his being ridiculed. For what Aristotle, the founder of the descriptive natural sciences, had written more than two thousand years ago, had passed into oblivion.

And how much greater is the resemblance which is borne to plants by those little animals that build the immense coral reefs; which turn again into rock that which the solvent power of the waters had at one time extracted from the cliffs! Very early in the history of the world, these little builders entered into the thoughts of man. Mythology attributed their origin to plants, which were said to have been thus transformed, as is related in the following legend: When Perseus had released the beautiful Andromeda from the terrible monster, he placed the head of the Medusa, whose frightful aspect turned to stone everything that beheld it, on some plants which he had taken from the ocean. But lo! these plants were immediately turned to stone. The water-nymphs soon came to satisfy their curiosity, and to marvel at the wonder. Playfully they scattered the seeds of these stone-plants into the ocean, and behold, the corals were created!

Not unfrequently hidden coral reefs prove a source of great danger to navigation. Two hundred and fifty years ago only thirty coral islands had been located in the strait between New Holland and New Guinea; now they number over one hundred and fifty, and soon, perhaps, this channel will become impassable. But is it not probable that other forces, besides the growth of the corals, are here actively at work? One of the most changeable parts of the globe is the neighborhood of that wonderful island, Australia. Numerous are the islets which there slowly arise from beneath the waters; numerous those which gradually disappear. Darwin was the first to show how sure a proof of geological changes such coral reefs are. The polyps which build them die at a depth of thirty metres, and the contact with the atmosphere is fatal to them. Hence, very deep coral structures denote a sinking, those above the water, on the contrary, an upheaval of the earth's crust.

And as the Jura, a part of the Alps and the Carpathian Mountains, display marks of such animal structures, it is a proof that all those mountain-ranges have, in the past ages, arisen from the ocean. They must have risen from a *warm* ocean, warmer than the climate of those regions is to-day, for the tropics only are the home of the reef-building coral-polyps. And how enormously they multiply under favorable circumstances is shown by the barrier-reef, four hundred miles in length, near the northern shore of Australia. Between it and the mainland there is a channel, over six miles in width, the water of which is calm, and always affords to vessels a refuge from the wildest storms.

And when we turn our gaze on the fauna existing between the branches of the coral, we behold animated life; a world in itself is spread before us; here dwell most of the various inhabitants of the sea—snails, shells, and sea-urchins, fishes and crabs of the queerest shapes. Here in the domain of color, where everything seems brilliantly attired, they are less easily discovered by their enemies than in the ocean. In fact, one can often observe that the exterior of animals is in accordance with their surroundings. The inhabitants of the desert have a sand-like color; those of the polar regions are of light shade; some caterpillars resemble the twig of a tree; some butterflies look like dried leaves; and a grasshopper has, on account of the shape of its body, received the name of "wandering leaf."

But the beautiful aspect presented by a branch of coral, when under water, immediately vanishes when it is removed from its native element, as the many little arms are then contracted. The skeletons of various species are, however, much sought for as ornaments, above all the black coral of India, which is considered a talisman. Next in value ranks the red coral, found near Algiers, and third in rank comes the white.

Another kind of plant-animals, which build structures like those of the coral, only not so large, not so hard, nor so lasting, are the *sponges*, sea-animals in the strictest sense of the term. The eastern part of the Mediterranean, and the Red Sea particularly, abound in valuable sponge-beds, on rocky soil. Numerous vessels arrive there every summer to collect the crop. Recently the cultivation of artificial sponge-plantations has been tried by taking a piece of fresh sponge, which still contained the slimy bodies of the sponge-animals, and planting the same in a favorable spot. The experiment succeeded admirably.

It seems easy and natural enough to turn our attention from the sponges to *chalk*. This very important writing-material is, as is well known, an accumulation of minute animal remains, or, more correctly speaking, of their calcareous shells. What large deposits they are capable of forming is shown by the chalk-cliffs of Rügen, by those of Great Britain, to which the island owes the name of "Albion" (white), and by those of Crete, from which the German word "Kreide" (chalk) is derived.

The chalk-cliffs arose from the ocean, but their later upheaval is due to volcanic eruption. The minute animals, which form the masses of chalk, are of various shapes; some resemble the houses of snails, some the cone of a pine, others again are staff-like.

The largest of the existing three hundred kinds have been known since the oldest of times, for they were found in the stones used by the builders of the Pyramids. Their incasement is greatly perforated, and from their pores they send forth numerous fine, slimy feet, which constantly fluctuate to and fro. By adhering closely to one another they cover their food-supply, and then gradually assimilate the same.

As the aurora borealis flashes through the darkness of the polar region, the nights in the tropics are made light by a curious, brilliant phenomenon: particularly bright sparks flash out in the ocean, at places where the waves break over rocky cliffs. Over one hundred kinds of animals may co-operate in producing this magic effect. Among these are the *Salpæ*, the life-history of which Chamisso learned on his voyage around the world. He was the first to prove that the *Salpæ* which cling together in chains do not vary at all from those swimming about singly. Other agents of a phosphorescent sea are the *Medusæ* (sea-nettles)—many-colored animals, possessing the most weird of forms. Some kinds have the shape of a bell; long filaments hang down from the edge, and in the center they have long arms to capture and paralyze their prey; in this they are aided by a number of those nettle-like organs mentioned in connection with the polyps.

Occasionally these queer creatures become visible on the surface, in masses several miles in extent. The material of which the body is composed seems to be chiefly water, as a *medusa*, about twenty pounds in weight, yielded when dried only thirty grammes of gelatinous flakes.

After the ominous sea-serpent, one of the most interesting of the beings which inhabit the mysterious depths of the ocean is Huxley's *Bathybius*, made of nothing but shapeless, motionless slime. It has been supposed to be the common origin of the animal and the vegetable kingdom, from which all beings have gradually been developed. But lately science has become doubtful as to its true properties, and has begun to question its organic nature; many naturalists consider it nothing more than gelatinous gypsum. Another animal, somewhat of this nature, which several years ago crossed the path of science, like a flickering will-o'-the-wisp, is the *Eozoön Canadensis;* gradually it has become more and more deprived of the animal characteristics once ascribed to it, and has been again assigned to the inorganic world.

Many are the errors and pitfalls that mark the path along which ever-searching Science strives onward to truth; and yet even these, in their way, show a triumph gained by the divine power of the human mind over its human failings!—(*Abstracted from Virchow and Holtzendorffer's "Sammlung gemeinverständlicher wissenschaftlicher Vorträge."*)

PROFESSOR EDWARD S. HOLDEN has sketched in "The Overland Monthly" a plan for co-operative photography of the stars. Under ordinarily existing conditions of doing the work, it would take an observatory one hundred and forty years to make a complete photography of the heavens, or ten observatories fourteen years. The desirability of several observatories engaging in the work together is therefore obvious. Photography may be expected to help in the discovery of new asteroids; in the search for the hypothetical planet beyond Neptune; in making star-maps; in finding stars that make no impression on the eye or telescope; in accurately fixing the aspect of the sky, as it is for the benefit of students in all the future and for comparative astronomy; and for many other purposes of practical and scientific importance.

SKETCH OF EDWARD L. YOUMANS.

BY HIS SISTER.

EDWARD LIVINGSTON YOUMANS was born at Coeymans, Albany County, New York, June 3, 1821. His parents, Vincent Youmans and Catherine Scofield Youmans, were natives of the same county. Livingston, as he was then called, was the first-born of seven children. When he was six months old the family removed to Greenfield, Saratoga County, within a short distance of Saratoga Springs. His parents were in narrow circumstances, and belonged to the hard-working class. Vincent Youmans had worked on his father's farm when a boy, but, having some mechanical capacity, he resolved to learn a trade, and accordingly, at the age of sixteen, was indentured for five years as an apprentice to a carriage-maker in Sheffield, Massachusetts. He was to be taught the business, and have some schooling. But 'Boss' Burrill was a hard master, and his apprentice got neither the schooling nor any proper instruction in the business. In all the five years, he attended school not more than three months, and seldom on consecutive days, while most of his time was spent in slavish toil on the Burrill farm. The boy felt outraged by this treatment, and showed signs of restiveness, when the wily wagon-maker lost no time in having the indentures revised, making the father liable for damage if the son ran away. Filial affection made Vincent submit to his lot, but he can not speak of this period of his life without indignation. Although his means were limited, yet, feeling deeply his own lack of knowledge, he was full of sympathy with the mental aspirations of his children, and made extreme sacrifices in furtherance of their education. He was, moreover, a clear-headed man, of fearless, independent spirit, who took an earnest and intelligent interest in all public questions. Before her marriage Livingston's mother was a school-teacher. Well endowed in body and mind, her long life has been spent in unwearied devotion to her family, and never had mother a more loving and dutiful son than was the subject of this sketch. She made home duties paramount, but she had opinions of her own, was frank in their avowal and spirited in their defense; and the lively, good-tempered canvassing of differences between father and mother were not lost upon their little ones, who early learned to respect and to defend their own sentiments. Whatever else may be said of it, the family circle was certainly never dull.

Livingston was a vigorous, active-minded boy, remarkable from a very early age for his desire to know, and for his readiness in learning. He took to books from the first, and read everything he could find to read. He was also fond of play, and especially of hunting, when old enough to handle a gun; and he used often to refer, in his days of blindness, to his clearness of vision at long range when sighting game.

He began going to school at the age of three, and was steadily in his classes for the next half-dozen years. The district school he attended, and the Presbyterian church, of which his parents were members, were of the New England type of that period. The home-spirit was eminently favorable to the growth of individuality, and the nearest household in the neighborhood—where my brother was a great favorite—consisted of very decided characters, well calculated to produce a marked effect on the receptive mind of the boy. It was here that Livingston got his first idea of the classics. When not more than nine years old, he became interested in a copy of Homer's "Iliad," which the eldest son was studying, and which contained a translation as well as the Greek verse. All his teachers at this period—the clergyman of the parish, an uncle just graduated, and the young men preparing for college who were winter teachers of the common school—helped incline him toward the classics. When about twelve years old, he prevailed upon his father, who then owned a little farm, and was going to Albany to market a small surplus of his crop of grain, to buy him some books. The list he prepared, beginning with those most desired, was a long one, but the proceeds of the sale of grain were only sufficient, after other indispensable purchases were made, to secure the first few volumes, among which were translations of Homer's "Iliad" and "Odyssey," Virgil's "Æneid," and Ovid's "Metamorphoses." These were his earliest possessions, and were made the most of ; other books were borrowed from neighboring clergymen or from citizens of Saratoga ; and a year or two later, with the proceeds of a patch of potatoes, planted by himself for the purpose, joined with a small contribution from his father, he was enabled to buy a "share" in a circulating library recently established in the vicinity. This library contained three or four hundred standard works in history, biography, poetry, and fiction, with a set of the "Encyclopædia Americana" ; but of science there was little or nothing, unless Buffon's "Natural History" might be ranked as science. With his fondness for books, no greater trouble could now come upon him than the disease of the eyes which, prevailing in the family during the winter of 1833–'34, attacked him when he was thirteen and a half years old. He could not let books alone long enough to permit a full recovery. Reckless of results, he persisted in reading whenever it was possible, in spite of protests and warnings. From this time until he was seventeen he was troubled with chronic weakness and frequent inflammations of the eyes, and when unable to read himself others read for him. During this period, the vigorous and abundant literature of the anti-slavery movement found its way into the home, his father being one of the earliest abolitionists in that part of the State. In the wide range of its discussions, the religious, ethical, political, economical, juridical, and ethnical aspects of slavery were treated by the ablest men of the nation. Livingston was familiar with every step of the controversy.

Having been interested in language-studies from early boyhood, he was in the habit, during these years, of practicing literary composition, and was also studying natural philosophy and chemistry in the district school. Despite his eye-trouble, he was still intent upon pursuing a regular course of study, and began his preparation for college in the spring of 1838, at the Galway Academy, under Professor Morgan. In the ensuing autumn he began to teach a common school, but his sight soon failed him, and from this time until he was thirty years old he was practically blind. The next two years were passed in the vain hope that time and rest would bring about a restoration of his vision. He was treated for a while by a local oculist of some reputation, but his eyes grew worse, and his general health became much impaired. This period, however, was not wasted. Much of it was spent in undisturbed reflection. His early habit of thinking for himself was now of great value. His excellent memory was stored with abundant material for thought, and perhaps nothing could have better promoted his solid education than those two years of quiet. But his habit of reading was also kept up ; his brothers and sister, who had always been his loyal pupils, and were interested in everything that interested him, became his sympathetic co-workers in the study of any subject he chose. The classics, however, no longer occupied his attention ; but he was already manifesting distinct tendencies toward scientific thought. Whatever taste or talent he may have had for experimental science, the state of his eyes prevented its pursuit. His love of science in its useful applications, and his enthusiasm for its popularization, were no doubt fostered by his blindness. Hence, while cut off from all part in the making of science, he was to find a most congenial field of labor in the work of its diffusion.

His eyes growing worse instead of better, in the fall of 1840 he came to New York for treatment in the eye infirmary. He remained there several weeks without improvement, when he was informed that the physician in charge regarded his case as hopeless. He left the institution at once, and visited other oculists in the city. Among these, Dr. Elliot gave him most encouragement, telling him that his eyes were by no means hopelessly ruined, and that he would undertake their cure for a fee of $150, to be paid in advance. The amount was at once obtained from home ; and it may be added that this was the last money he would consent to accept from that source, ever after relying upon himself for support. The previous two years of indoor life, with occasional seasons of reducing medical treatment, had seriously impaired his vigor, and he was suffering under a constant liability to take cold on the most trifling exposure. After a few weeks of continuous but slow improvement, he began to see well enough to go about and help himself a little, and was encouraged to form plans for future work, when suddenly his eyes became again inflamed, and he was thrown back into his old condition of blindness. This state of health continually prevented his complete recovery of sight; and so for the next twelve years he very rarely had vision enough to read ordinary type.

On leaving the infirmary, Livingston boarded for a time in a house with several printers of the more intelligent class. Their society suited his tastes, and they took a strong personal interest in him. They brought the important new books of the day to his attention, and read them to him in the intervals of their work. After a year or two he had the good fortune to be received in a Quaker family, where he was treated quite as one of the household. His New York home continued to be with these excellent people for many years. The Quakers called him by his first name (Edward), as it was easier to speak, and the other was soon dropped, except in his family and among the friends of his youth.

During the early years of his life in New York, Edward sustained himself by literary labor, of a rather miscellaneous character, having devised a writing-machine which could be carried in the pocket, and by the aid of which he was able to work without assistance. In a few months, under Dr. Elliot's treatment, he became sufficiently familiar with its routine to carry it on, with my assistance only; and after this he often came home to Saratoga with a carpet-bag full of books, enough to occupy us for weeks, or until an unmanageable relapse compelled a return to his physician.

It must not be inferred that this self-education was a hap-hazard affair. On the contrary, it was carried out with a definite purpose, and with the utmost perseverance. Of course, all the early plans about going to college were now ended, and quite as much from choice as from necessity. His knowledge of science, and particularly of applied science, had been steadily growing, and he had studied with especial care all the important works on scientific agriculture. It was impossible for him to rest with half-knowledge, but his blindness made the chemical side of this subject especially difficult. This obstacle was partly overcome in the summer of 1843, when I had the advantage of attending a very full course of lectures and experiments in chemistry, given at Fairfield, New York, by Professor Mather. After this we could manage the subject fairly well together; but, unable as he was to observe the characteristic behavior of chemical substances, he could not readily individualize them. His ideas about them, therefore, were easily confused, and he was constantly striving to make them more definite.

In the fall of 1845 I was able to join my brother in New York, and give all my time to his assistance. When not occupied with tasks of immediate concern, he now gave his attention to the execution of a work already carefully thought out, which should give the synchronous progress of invention, discovery, and learning, from the beginning of recorded history. Many months and a great deal of labor were devoted to research in the various public libraries, and when the undertaking was far advanced toward completion it was forestalled by another work covering substantially the same ground. This was a bitter disappointment, but, wasting no time in regrets, Edward was soon at work on an arithmetic, in which the problems were made up from the constants of science. This enterprise also was anticipated by another book of similar character. But the labor thus bestowed was not wholly lost; for it helped to educate him in the line of his future work.

Although occupied most of the time as above stated, my brother kept up the study of agricultural chemistry, and, to this end, ever since my arrival in the city he had been seeking for a laboratory where I could enter as a pupil; but none was found that would admit a woman, until Dr. Antisell, one of the Irish exiles of 1848, consented to receive me. Here I at once began the studies preliminary to the analysis of soils. By the time I was able to make such analyses, my brother had become convinced that they were of no value in practical agriculture. But, in our talks over this laboratory experience, he was still hindered by the old difficulty of dealing with chemical phenomena at second-hand; and now an unexpected consequence followed. When he reflected that chemistry was fast becoming a popular branch of education, and that, so far as its processes were concerned, the youths who were studying it might be classed, along with himself, as blind, their situation naturally interested him. Occupied with this subject, there one day arose in his mind a scheme for picturing atoms and their combinations that would bring the eye of the student into more effectual service. Out of an impulse to help this unfortunate class came the "Chemical Chart," in which he succeeded in making clear to the eye, and easily remembered, the most important principles and laws of the science as it was then understood. This "Chart" represented the principal elements, binary compounds, and salts, and the minerals of chief interest to geologists and agriculturists, together with the most important organic bodies. Atoms of the different elements were shown by diagrams of different colors, the relative sizes of which expressed their combining ratios, and the compounds exhibited the exact numbers of the respective atoms that unite to form them. The chart was at once accepted as a valuable assistance in teaching chemistry by many leading educators throughout the country, and its use led to frequent requests that its author would prepare a book to go with it. The text-books consulted in its preparation had left the impression that this science was not so attractively presented to the learner as it might be. He thought that chemistry could be made enticing as well as intelligible to learners who had not the help of experiments in its pursuit.

When asked to make a book himself, however, he did not at first entertain the idea; but the thought grew upon him, and by degrees took definite shape. Acquainting himself with all the standard text-books, and, clearly perceiving what he wished to accomplish, he set about the preparation of the "Class-Book of Chemistry," giving all his time to the work. When it became a question of finding a publisher, preceding events had much to do in deciding his course. He was already indebted to Mr. W. H. Appleton for many kindnesses in the loan of valuable books, and for sympathetic interest in his undertakings. It was, therefore, most natural that the manuscript of his book should first be offered to D. Appleton & Co. Their reader, Mr. Tenney, a stranger to the author and his circumstances, gave the work his unqualified approval, and used afterward to refer to the fact in proof of his good critical judgment. The "Class-Book" appeared in 1851, and its clear, lively style, its brevity, freedom from technicalities, and continual reference to the important practical applications of chemistry, soon made it a favorite with beginners in the science. It has been twice rewritten, and its enduring popularity is shown by the fact that the sale of its three editions has reached the number of 144,000 copies.

The "Chemical Atlas," published in 1854, was an extension of the method employed in the "Chart." The scale of illustration was much reduced, and it contained maps portraying elementary chemistry, the chemistry of geology, homologous series of compounds, nitrogenized and non-nitrogenized principles of food, and giving examples of isomerism, and the theory of compound radicals. The great natural processes of combustion, respiration, fermentation, and the chemistry of light or solar dynamics, were also pictorially presented. The accompanying text was carefully written, and marked by the same qualities of style as the "Class-Book." But all these publications were based upon the binary theory of the composition of matter, and when this gave place to the new chemistry, the "Atlas" and "Chart" were no longer of use, but the "Class-Book" was rewritten.

After the publication of the "Class-Book," Edward's health underwent a marked improvement. He gained in weight, his face became round and ruddy, and at thirty-five he looked much younger than at twenty-five. His countenance gradually lost the introverted expression of the blind, so marked in his portraits between the ages of twenty and thirty, and his eyes became so much stronger that he could now say farewell to the doctor. While his eyes would bear a great deal of use, he was often tempted to overwork them, when they would give out for a time, but by rest and other means they were soon at his service again. He was, however, distressingly near-sighted; so that except his familiar friends, whom he recognized by traits of form or movement, he did not know people unless they were within a foot or two of him. This circumstance was a great bar to his enjoyment of general society. It made him timid and hesitating, and often occasioned awkward and most embarrassing mistakes although he was by nature the most sociable and genial of men, and delighted in society where he felt at ease.

He published a book in 1853 entitled "Alcohol and the Constitution of Man," which grew out of an article of his on the "license system," covering a full page of the "New York Tribune." His argument was based upon the view, put forth by eminent scientists, that alcohol is in all cases a brain-poison. The temperance people urged him to make a book of it, which he accordingly did ; but further knowledge of the subject made him uncertain of his ground, and the work was allowed to pass out of print.

In illustration of his dependence upon others at every step of his life, it may be stated that in 1853 a younger brother returned from a four-years' residence in California, and, being unsettled as to his future, was persuaded to undertake the establishment of an experimental farm at Saratoga. But, before matters had taken shape, it became apparent that the young man could not be content with the quiet labors for which there had been neither emotional nor intellectual preparation, and the enterprise was abandoned. Feeling the importance, in the light of this experience, of early scientific culture, Edward did all in his power to promote the scientific education of a much younger brother, who many years later began with him the management of this magazine, and without whose co-operation it would not have been attempted.

In 1856 Edward read in a foreign periodical a review of Herbert Spencer's "Psychology," which had been published the year before ; and his interest was so aroused that he at once imported the book. This led to a correspondence with the author concerning the publication in this country in book form of his essays on education, with the result that D. Appleton & Co. brought out the work in 1858. Thus began my brother's acquaintance with Mr. Spencer, and co-operation in the publication of his writings, which was kept up to the end. In 1859 he accidentally got hold of a copy of the English programme of Spencer's "System of Philosophy," which was to be issued in parts to yearly subscribers. Edward immediately wrote to Mr. Spencer, volunteering to aid the project in this country, and was informed that it would require two hundred and fifty more subscribers, in addition to those already secured in England, to justify the expense of an American edition. The needed names were soon secured ; and an arrangement was also made with the Messrs. Appleton to reprint Mr. Spencer's earlier works. From the beginning of his acquaintance with these writings, my brother was convinced that they were destined to exercise great influence in this country, and this opinion has been fully confirmed.

Of my brother's experience as a lecturer, there is little room here to speak. He early showed an aptitude for making scientific subjects intelligible and attractive to the unscientific, and was an impressive public speaker. His first course of lectures was on "The Chemical Relations of the Living World to the Atmosphere," and dealt with the geological history of the earth and with those large generalizations concerning the respiration of plants and animals that were shown to depend ultimately upon the forces of the sunbeam. These lectures were early examples of his fondness for broad scientific conceptions that bring together all departments of Nature, and his later lectures upon the "Chemistry of the Sunbeam," the "Dynamics of Life," etc., by which he was at one time widely known as a popular teacher of science, are also illustrations of this mental tendency.

The "Hand-Book of Household Science," published in 1857, was designed as a text-book for girls, and is another illustration of my brother's passion for applied science. He believed that the bearings of science upon the economy of the household was "first in the order of importance among things to be considered by rational and civilized people"; and that "it is the duty of popular education to communicate that information which can be reduced to daily practice and yield the largest amount of positive good." The book was a most painstaking labor, and is a mine of useful knowledge concerning matters of constant interest to everybody.

Professor Youmans was married in 1861 to Mrs. William L. Lee, the widow of a distinguished lawyer and jurist, and a lady of culture, refinement, and much critical literary ability. That a wife of such nice perceptions and intellectual gifts should earnestly sympathize with the literary and scientific work of her husband was to be expected. As his amanuensis, and as an assistant and companion in the occupations, correspondence, and travel, by means of which he was brought into intimate relations with the leading thinkers of England and America, she rendered him valuable aid which he highly appreciated.

"The Correlation and Conservation of Forces" (1864) is a collection of essays and addresses by the most eminent leaders of science concerning the new theory of the relations of forces, with an introduction by the compiler, prepared in order to bring forward certain facts in the history of discovery concerning the correlation and conservation of forces in which we as Americans have a special interest; and also to indicate several applications of the principles not treated in the body of the volume. At one time my brother was strongly urged to take the presidency of Antioch College. He did not entertain this proposal, but when asked to take the chair of Chemistry in that institution as non-resident professor, he accepted the appointment provisionally, and gave a course of lectures there in 1866. Various circumstances, however, made it impossible to continue the arrangement.

"The Culture demanded by Modern Life" (1867) presented a series of addresses and arguments on the claims of scientific education by more than twenty English and American thinkers. The editor was represented in the list by a lecture on "The Scientific Study of Human Nature" and an introductory essay on "Mental Discipline in Education," in which he attempted to show that a course of study mainly scientific not only meets the full requirements of mental training, but also affords the kind of culture or mental discipline especially needed in this country.

Besides his labors as a lecturer and in the preparation of his own works, and his efforts in behalf of Mr. Spencer's publications, Professor Youmans had all along been deeply interested in the reproduction here of the works published abroad by the leaders of modern scientific thought. Among the earliest which he urged the Appletons to republish were those of Whewell, Buckle, Darwin's "Origin of Species," and the writings of Spencer and Tyndall. He went to England several times on this errand, and, as a result of his exertions, the works of Huxley, Lubbock, Darwin, Lyell, Bain, Tyndall, Maudsley, Sully, Hinton, Bastian, Roscoe, Simpson, Proctor, Helmholtz, Bagehot, Mill, Carpenter, Mattieu Williams, and many others, were reprinted by the Appletons, and have been very popular with thoughtful readers in this country. The arrangement with the publishers was that the authors should be paid a publisher's copyright at the customary American rate.

Chiefly interested in the works of scientific and philosophical authors, who suffer most from lack of international copyright because their productions are in comparatively small demand, Professor Youmans planned the "International Scientific Series," and spent a year in Europe making arrangements for it with authors and publishers. After not a little hard labor, the series was finally organized on the basis of simultaneous publication in London, New York, Paris, Leipsic, Milan, and St. Petersburg, and of payment to the authors on the sales in all countries. The first volume, issued in 1872, was Tyndall's "Forms of Water," and was followed by Bagehot's suggestive work on "Physics and Politics." Other books that attracted attention to the merits of the series were Cooke's "New Chemistry," Spencer's "Study of Sociology," Draper's "History of the Conflict between Religion and Science," and Schmidt's "Doctrine of Descent and Darwinism." The series has reached, in Mr. Angelo Heilprin's "Geographical and Geological Distribution of Animals," its fifty-seventh number, and as a whole constitutes the most successful popular presentation of scientific and philosophical ideas ever attempted. None of the books have enjoyed a wider circulation than the "Study of Sociology" and the "Conflict between Religion and Science," both of which are remarkable for the boldness of their statements of new ideas. It thus appears that the foreign authors whose works were in charge of Professor Youmans have been for years in practical enjoyment of international copyright at the hands of Messrs. Appleton by a systematic voluntary arrangement.

"The Popular Science Monthly" was started by the Appletons, at the suggestion of Professor Youmans, in 1872. The leaders of scientific thought in Europe were actively publishing their views in periodicals and in the transactions of learned societies, but the American public were without any means of keeping up with the drift of the new movement. Professor Youmans had persuaded Herbert Spencer to write the volume of "The Study of Sociology" for "The International Scientific Series," and it had been arranged that the chapters should first appear serially in "The Contemporary Review" in London and in some American magazine. Professor Youmans made arrangements for its publication in "The Galaxy," to which advance-sheets were to be sent. But the first installment came too late, it was said, for publication at the time agreed upon, and it was at this juncture that the necessity of establishing a new scientific journal in this country became apparent. In less than two weeks from the first conception of the project, and two days before "The Galaxy" appeared which was to have contained the delayed article, the first number of "The Popular Science Monthly" appeared. Considering that it was a scientific periodical, its success has been unprecedented.

But in the height of its usefulness the busy life is ended. Professor Youmans's constitution, originally robust, had been impaired by his sedentary habits. Want of sight left no inducement to out-of-door pursuits, while his chosen work always kept him in-doors; and it was not strange that, when exposure came, as it did in the winter of 1880–'81, his system should yield to the strain. He suffered a severe attack of double pneumonia early in the season, and this was followed by a succession of relapses, which left his lungs in a state so diseased that they never recovered. He was told by his physician that his chance for long life lay in the country and in open-air occupations; but conformity to these requirements seemed to him impracticable, and he went on with his usual work, though failing gradually in strength. In the late winter of 1885 he went South, but derived little benefit, and the following season declined to repeat the journey. About a year ago he was overtaken with loss of appetite, and consequent loss of flesh and strength, and then realized that his days were nearly numbered. During the last six months he was very feeble and emaciated, but his long sickness was borne without complaint, and his unselfishness and care for others were conspicuous to the last.

EDITOR'S TABLE.

DEATH OF PROFESSOR YOUMANS.

EDWARD L. YOUMANS, the projector of this magazine, and its editor from the opening number, died at his home in this city on the morning of Tuesday, January 18th, in the sixty-sixth year of his age. For nearly forty years he has been before the public as a teacher of science, either through his published works, on the lecture-platform, or in an editorial capacity; and though it may almost be said that he was cut off in the prime of his intellectual powers, it has been the fortune of few men of his generation to accomplish a larger amount of useful work. Leaving it to others who, less drawn by ties of kindred, and less dominated by the influence of long association, will be more competent to measure the impress he has made upon American ideas, it will be proper here to refer to the purposes and hopes which animated Professor Youmans in the establishment and conduct of "The Popular Science Monthly."

For years before the plan of the publication took definite form, he was frequently heard to deplore the inhospitable attitude of the periodical press, particularly in this country, toward the growing influence of science in the world of modern thought, and it was in order to open a way by which this influence might the more readily find access to the educated classes that the publication of the "Monthly" was first resolved upon. One of the earliest obstacles encountered, even before the magazine was fairly under way, was the active hostility of more than one of the leading periodicals of that time. The conductors of several of these journals, literary as well as religious, were intolerant of the views to which it was, among other things, the purpose of the "Monthly" to offer a channel of expression. Indeed, not only did they refrain from printing the writings of the leading scientific thinkers, but they seemed ever ready to condemn any means that might be employed to bring those writings before the public where they could be judged upon their merits. This was so much the case fifteen years ago, when the "Monthly" was started, that not one of the prominent magazines in the country would publish Mr. Spencer's papers on the "Study of Sociology"; yet so great was the change in public sentiment on these subjects, wrought by the "Monthly" under the guidance of Professor Youmans, that two of these very journals were among the earliest and most liberal applicants for Mr. Spencer's philosophical favors when he visited America ten years later.

Professor Youmans's conduct of this magazine has been marked by a sincere devotion to the search for truth and the diffusion of the most enlarged knowledge; by a careful exclusion of the merely sensational; by a vigilant solicitude to avoid misleading its readers through putting forth as science the unaccredited theories which so persistently seek public expression—with a quick readiness to correct errors into which he may have been inadvertently betrayed; and by a watchful care to keep abreast of the progress of science, particularly in its bearing on philosophy, education, ethics, social economy, etc.; and, above all, by constant adherence to the principle that "the highest value of science is derived from its power of advancing the public good."

Loyalty to the spirit and principles thus outlined was indicated in the opening announcement of the "Editor's Table" of the first number of the "Monthly," where it was declared that the journal had been started "to help on the work of sound public education by supplying instructive articles on the leading subjects of scientific inquiry." It was there shown, further, that the meaning of the term science was widening, that it had come to be regarded as applying to the whole of Nature; "as being, in fact, a method of the mind, a quality or character of knowledge upon all subjects of which we can think or know." This implied a more critical method of inquiry in fields not before so strictly dealt with. Whatever subjects involved accessible and observable phenomena came within its range; it was the common interest of rational beings; and included in the immense extension of its conception all subjects of human interest. There was growing up a valuable literature of popular science in the shape of instructive essays and lectures from men who were authorities upon the subjects which they treated, for the diffusion of which adequate means were not yet provided. The "Monthly" would afford this, and in doing it would appeal not to the illiterate, but to the generally educated classes, and would seek to enable them to carry on the work of self-instruction in science.

To him may be literally applied what he wrote of Agassiz, on the occasion of his death: "He [Agassiz] had great enthusiasm and impulsiveness, and the whole fervor and intensity of his nature was spent in the single-minded pursuit of science. Not content with what he could himself know, and do, and enjoy, he was powerfully impelled to make others the sharers of his knowledge, his activity, and his pleasures. He not only won them to him by his geniality and his cordial and unaffected manners, but he inspired them with his own purposes, and moved them to his own ends." He was not content to be merely a scatterer of his own stores of knowledge; "he had a profound interest in popular education, but the soul of that interest was for improvement in its methods. In the matter of public instruction he was a revolutionist and a propagandist. He warred with current ideas and consecrated practices. He condemned in the most emphatic way the wretched lesson-learning routine that prevails in the schools. He denounced our wordy and bookish education as baseless and unreal, and demanded such a change in our systems of instruction as shall bring the pupils face to face with Nature herself, and call out the mind by direct exercise upon phenomena—the facts, laws, relations, and realities of the world of experience." All this is true of Professor Youmans; but it never entered his mind to assail existing systems till he believed he had something better and more effective to put in their place.

His faith and his heart were in his work, and he executed his self-imposed duties with a vigor, an earnestness, and a thoroughness that are peculiar to those who believe in what they are doing, and whose highest satisfaction is obtained in the consciousness of benefits conferred. Leaving this work—so persistently and so successfully carried on—to other hands, he has left along with it an example of conscientious devotion to principle, of outspoken allegiance to truth, and of unsparing self-sacrifice, that will remain a precious heritage to his friends, and may fitly serve as an inspiration to all who are striving for the general good.

FUNCTIONS OF THE STATE.

IN his article on "Socialism," in the new "Scribner," General Francis A. Walker, of Boston, advances two opinions that seem to us open to the gravest question. In the first place he apparently approves of the exemption of church property from taxation in so far as the practice is grounded on a belief that the interests of public order will thereby be subserved. In the second place he bestows "the heartiest approval" on the "socialistic movement," as he himself describes it, for transferring "power and discretion in the matter of the education of children" from the family to the Government. Let us very briefly discuss both points.

The exemption of church property from taxation is equivalent, General Walker tells us, to a "subsidy of many millions annually. . . It is claimed," we are further told, "that the services of this agent are worth to Government more than the taxes which the treasury might otherwise collect from the smaller number of churches and missions which would survive the assessment of the ordinary taxes, and that the remaining tax-payers really pay less, by reason of the reduction in violence and crime hereby effected." Now the question that presents itself to our mind is this: What view might we expect a dispassionate and capable observer, like the President of the Massachusetts Institute of Technology, to take of an utterly unverified and utterly illogical claim of this nature? That it is unverified no one can deny. What *facts* are there to prove that, if church property paid taxes like other property, crime and violence would increase, and the general rate of taxation be advanced? Absolutely none. That the claim is an illogical one is equally evident. Why should state aid to the churches, if it really assists the cause of order, stop short at the exemption of church property from taxation? If a few millions in this way are of so much benefit, why not try the effect of a few millions more in the payment or supplementing of the salaries of ministers? Why not have a fund for the erection of church-edifices in spiritually destitute districts? Why not subsidize the Bible Society? Why not distribute tracts through the Post-Office letter-boxes? There is really no end to what the Government might do to aid the churches; and it is really very odd that any one should *seriously* pretend that the *whole* duty of the Government in the matter is done when it has "dead-headed" the churches on the assessment-roll. Or look at the same question from another side. If it is conceded, as it probably is by the great majority in this country, that state patronage of the Church is hurtful to the life and activity of the latter, why should it be held that the particular form of state patronage involved in exempting ecclesiastical property from taxation is beneficial? Why should it *not* be held that just as the Church has gained in spiritual vitality by being cut off from other forms of state support, so it would further gain by shaking itself free from this last remnant of the old system? If this view is correct—and we should like to know what solid arguments can be advanced against it—then, instead of a gain to social order by the remission of the taxes on ecclesiastical property, there must be an injury to that very cause through the moral injury inflicted on the churches. The whole argument referred to by General Walker is so hollow, so unscientific, so manifest a begging of the question, that we can not but be surprised at his omission to denounce it as such; and still more at his putting it forward as an argument valid enough, if only used genuinely, in the interest of good government. No one knows better than General Walker that the sincerity with which an argument is used has nothing whatever to do with its logical validity, but depends wholly on personal conditions. A very ignorant or stupid man may use with perfect sincerity an argument which a better-informed and clearer-headed man could not use without conscious sophistry. We should very much like to read an article from General Walker's pen dealing with the one question: *Should ecclesiastical property in the United States be exempted from taxation?* We feel persuaded that, when he came to give us his own undiluted views upon that point, he would deal somewhat trenchantly with the argument above referred to, and not altogether in the direction of the brief notice contained in his article on "Socialism."

Next, as to the transfer to the state of the "power and discretion in the matter of the education of children." This, we are told, "deserves the heartiest approval . . . as a scheme for accomplishing good through state action, in a field properly pertaining to individual initiative and enterprise." It is a little difficult to understand how a field that "*properly* pertains to individual initiative and enterprise" can *properly* be encroached upon by the state. Some explanations on this point would be very acceptable. How can it be said that the field of education properly pertains to individual initiative and enterprise if the contention, indorsed by General Walker, is correct, that "the individual members of the state would be richer, and happier, and better, if power and discretion in the matter of the education of children were taken away from the family and lodged with the Government"? It seems to us that it is altogether too soon to bestow our "heartiest approval" upon this particular "socialistic movement." General Walker himself notes that "the immediate effects of popular instruction in reducing crime are in dispute." He might also note that this doubt has arisen almost wholly since the state has taken so prominent a part in the business of education. When education was in the hands mainly of the family, an education was universally thought to be the very best gift a father could bestow upon his son. Now, that the state is forcing education upon all, the value of the article has sensibly decreased; and many are beginning to doubt, looking both at moral and at intellectual results, whether in this matter society is not working in a wrong direction. A vast amount of thought has been bestowed during the last half-century upon educational methods; and yet we seriously doubt if there was ever more dissatisfaction with the general results of popular education than there is to-day. We could refer General Walker to an article that appeared a year or two ago in one of the leading newspapers of his own city, the "Boston Herald," setting forth the difficulty a certain insurance company had in finding, among a score of graduates of the Boston grammar-schools, a single youth competent to take a junior clerkship, the only qualifications for which were fair skill in figures, good handwriting, and a certain knowledge of the rules of English composition. Is it not the fact that "commercial colleges" have sprung up all over the country to supplement the deficiencies, from a business point of view, of the public schools? And in spite of the vast disadvantage at which state competition places all private tuition, the number of private schools and academies advertised in the papers is still very great. The effect upon the home of the wide assumption of educational functions by the state has yet to be fully ascertained; but already there are grave reasons for thinking it has been far from favorable. It is no small matter to take from the family the "power and discretion in the matter of the education of children"; and before we talk of giving our "heartiest approval" to the change, we should be quite sure that it is not going to loosen the very foundations of society. Our own opinion is that education is no part of the functions of the state, and that it would be better, therefore, to leave it in the hands of the family, even though the result were to show, in the course of a few years, a larger proportion than now of that kind of illiteracy which consists in not being able to read or write. We have known illiterates of that kind who could "give points" to people who could both read and write in the matter of common sense and general information. The question is too wide a one for discussion in these columns; but we desire here to record our conviction that when "power and discretion in the matter of the education of children are taken away from the family and lodged with the Government," the rights and duties of the family are seriously invaded, and that no good can come of it in the long run.

Mr. Grant Allen visited America last year for his health, and not on an errand of scientific observation. Yet, that his well-known habit of looking closely at what he saw, and questioning it for the instruction it might yield, was not relaxed, is shown by the very interesting and suggestive article which he has contributed to our pages this month on "A Mount Washington Sandwort." The history of the plant, as he elucidates it, is most interesting, and can not fail to give us broader views of the effect of glacial action upon the distribution of life over the earth.

LITERARY NOTICES.

The First Three Years of Childhood. By Bernard Perez. Edited and translated by Alice M. Christie. With an Introduction by James Sully, M. A., author of "Outlines of Psychology," etc. Chicago: A. N. Marquis & Co., 1885. Price, $1.25.

The aim of the author in the preparation of this work is to follow out, in little children, the gradual awakening of the mental faculties during the first three years of life. He is a painstaking, exact observer, and seems in some way to have had exceptional opportunities for the prolonged acquaintance of a good many different babies from the first days of their mundane experience. He has, besides, made excellent use of the labors of others in the same field, when their facts were well observed and well described, and their ideas grew out of real experience. His abundant material is carefully sorted and arranged for illustrating and enforcing his view of infant psychology. His facts are simply described, and are most frequently given in the form of anecdotes, and his interpretations of them are both sympathetic and scientific. He has a rare faculty of interpreting the external signs of infantile feeling. M. Perez is deeply interested in all practical questions concerning education, and is the author of a work entitled "Education from the Cradle." He is a good physiologist and psychologist, and notwithstanding his native fondness for children, he subjects them to rigorous scientific scrutiny. M. Perez is an intelligent evolutionist, and is also deeply interested in comparative psychology, and in his interpretations of the facts of child-life he makes excellent use of all the latest developments of science. An idea of the scope of the work will be best gained by a glance at the table of contents. Chapter I treats of the faculties and first impressions of the new-born child. Chapter II describes the motor activities—at the beginning of life, at six months, and at fifteen months. Chapter III considers the emotional sensations and the first perceptions. Chapter IV deals with the instincts, general and special, and Chapter V with the sentiments. Chapter VI discusses intellectual tendencies under the heads of Veracity, Imitation, and Credulity. Chapter VII is devoted to the will; and Chapter VIII to attention and memory. In Chapter IX association and imagination are considered; and Chapter X, on the elaboration of ideas, treats of judgment, abstraction, comparison, generalization, reasoning, and errors and illusions. The remaining three chapters are given severally to expression and language, the æsthetic sense, and the moral sense.

The introduction by James Sully, author of "Outlines of Psychology," is a valuable addition to the work. We quote his closing remarks: "A last feature of this volume which is deserving of mention is its thoroughly French form and style. The reader feels at every page that he is listening to a Frenchman who knows how to shape his materials, give order and arrangement to his exposition, light it up with pertinent illustration, and adorn it with the graces of style. While in places the author ventures a few steps into the darker recesses of metaphysical psychology, he never forgets that he is writing a popular work. And he has succeeded in producing a volume which, while it will be of special interest to the scientific student, will attract the general reader as well.

"It may not be superfluous to say, perhaps, what I feel sure the author himself would indorse, that this volume makes no pretension to be a final and exhaustive study of its subject. A complete theory of the infant mind will need to be built up by the combined efforts of many observers and thinkers. In the region of psychology, much more than in that of the physical sciences, repetition of observation and experiment is needed to check and verify the results of individual research. The secrets of infancy will only be read after many pairs of eyes have pored over the page. Though, as observed, M. Perez has made his studies unusually wide, it may be reasonably doubted whether, in some cases, he does not give exceptional instances as typical and representative. Certain it is that his notes respecting the first appearance of sensations—e. g., those of taste and smell, of the perceptions of distance, etc., of the movements of grasping objects, etc.—differ in some important respects from those of other observers. In certain particulars, too, this volume is less full than some other records, notably that of Professor Preyer's 'Die Seele des Kindes,' which, as it was published after the work before us, is not referred to. Hence, the student who wants to be quite abreast of the present results of research, will do well to read other records in company with this. This circumstance, however, does not in the least detract from the value of 'The First Three Years' as a rich mine of facts, and one of the fullest if not, indeed, the very fullest, monograph on its subject."

Elements of the Comparative Anatomy of Vertebrates. Adapted from the German of Robert Wiedersheim, by W. Newton Parker, with Additions by the author and translator. With 270 Woodcuts. Pp. 345. Price, $3.

We are indebted to an Englishman for another excellent work on the comparative anatomy of the vertebrates. It is true that this publication is a translation of Wiedersheim's excellent work, published at Jena in 1884. But a book rescued in this way from a nation which is too often content with books printed on poor paper, with crabbed type and interminable sentences, and placed before us by an original worker with his own annotations and additions in language and type which are as luminous as they are precise, is a boon for which one may be truly thankful.

The subject-matter is arranged according to organs and not according to groups of animals, and one must have a general knowledge of the animal kingdom, and especially of its classification, to fully profit by the work. This arrangement, as the author says, "seems to be the only possible one if the book is to be founded on a scientific basis, for it is most important that the student should grasp the fact that there has been an evolution of organs as well as of animals." The illustrations are numerous and most excellent. There is nothing more exasperating to a student than a dingy and well-worn anatomical woodcut, rendered a perfect muddle by a halo of diminutive and broken type connected with equally broken lines which penetrate the drawing like skewers, and become hopelessly entangled in a mesh of muscular fibers and tissues. It is refreshing to get hold of this work of Wiedersheim's with its clear and ample engravings, rendered intelligible by large guiding initials, with their dotted lines connecting definitely with structural details in the drawing, and there stopping.

Some slight errors, however, have crept in, as the statement that the tarsus of birds consists in the embryo of three elements instead of four. As the author so often deals with his subject ontogenetically, he should have referred to the rudimentary pelvis in the whales and certain limbless reptiles. As excellent descriptions with diagramatic figures are given showing the development of the feathers and hair, a paragraph might have been devoted to the development and various modifications of the claw, hoof, and nail, with the statement that in certain birds the embryo possesses the rudiments of nails on the digits of the wing.

The chapter on the urogenital organs, accompanied by excellent diagrammatic as well as shaded illustrations, especially those showing these parts in the monotremes and marsupials, will be appreciated by students.

Each section of the subject closes with

a brief bibliography, and the book ends with a good index.

Precious Stones in Nature, Art, and Literature. By S. M. Burnham. Boston: Bradlee Whidden. Pp. 400, with Plate. Price, $3.50.

When beauty in any mineral that may be found in Nature is accompanied by a corresponding rarity of the same, so that possession for ornamental purposes is only possible to those having wealth or power, the material belongs to the class of precious stones. Although precious stones are not indispensable to the world's progress, they flatter human vanity, and have therefore a not unimportant place in human affairs. The large money value a precious stone represents compared with its volume, rendered this sort of property valuable in former times as an additional medium in commercial interchange; the perfected banking methods of the present day have, however, relegated precious stones to their proper field—adornment and as curiosities.

The author does not discuss the usefulness of precious stones. Since they are used, have been always used, and are a very important article of commerce and industry, he tells us all he knows about them or has been able to gather from other authors; origin, properties, classification, prices, trade, pawns, sumptuary laws, size, collections, crown-jewels, secular and sacred uses, their place in literature, mystical properties, and engraving on precious stones. Many historical facts are given which make the book very readable and interesting. The above subjects are distributed in the first nine chapters. The following chapters are devoted to the description and histories of the different varieties of precious stones. Among these the diamond occupies the first place. In two chapters the history, home, mining, trade, polishing, etc., of the diamond are minutely given, accompanied by much historical information. Another is devoted to historical and remarkable diamonds. The history of each of these stones—or as much as is known—is given in each case. The record is not what would be considered the best part of human nature. Murder, wars, artifice, theft, plunder, and treachery are the jewels on which the larger number of these remarkable diamonds are set, and very few of these historical diamonds have a clean history. The largest diamond known is the Braganza, or King of Portugal, weighing from sixteen hundred and eighty to eighteen hundred and eighty carats uncut, the genuineness of which is, however, doubted. There are two, the Matan and Nizam, weighing over three hundred carats, uncut, and seven, four of which are cut diamonds, weighing between two and three hundred carats. The diamond loses about one third of its weight by cutting.

The diamond is pure crystallized carbon. The stones which belong to the class of the precious corundum, which is supposed to be nearly pure alumina, are the most valuable after the diamond. They are sapphire, asteria, emerald, amethyst, topaz, and ruby.

The beryl class includes several varieties: the emerald, acquamarines, and topaz, which, to distinguish them from those of the corundum species, are termed Occidental, while these are termed Oriental. The difference in composition is that the beryl species contain silica and other substances besides alumina. Opals and pearls: spinet, garnet, tourmaline, turquoise, lapis-lazuli, chrysolite, chrysoberyl, iolite, kyanite, apophyllite, labradorite, and other gems, and the crystals of the quartz family, are described in the last four chapters.

There are six appendices, giving the size of the largest diamonds; classification of precious stones according to their constituents; hardness, and specific gravity, and relative hardness, relative specific gravity, localities in the United States where gem-minerals have been found.

Mind, No. XLV. January, 1887. London: Williams & Norgate.

The present number is unusually rich. The leading article is by Professor William James, of Harvard University, entitled "The Perception of Space." Professor Henry Sidgwick writes a criticism upon Dr. Martineau's ethics, and James Ward, author of the article upon psychology in the new edition of the "Encyclopædia Britannica," replies to some comments of Professor Bain upon his work. J. M. Cattell, Ph.D., contributes an account of some interesting experiments on the association of ideas. Five critical notices by Professor A. Seth, Thomas Whittaker, James Sully, Grant Allen, and Professor R. Adamson, deal respectively with vol. ii of J. H. Green's philosophical works, C. Rendouvier, J. Delbœuf, M. Guyau, and J. Volkelt. All these criticisms are exceptionally able. The notes upon new books are copious and interesting.

Hand-Book of Zoölogy, with Examples from Canadian Species, Recent and Fossil. By Sir William Dawson, LL. D., F. R. S., etc. Third edition, revised and enlarged. Montreal: Dawson Brothers, Publishers. Pp. 304. With 317 Figures and 9 Plates. Price, $1.25.

This little book, as its name implies, is a hand-book of zoölogy. Chapter I, under "Physiological Zoölogy," deals with the tissues and functions of the animal. Chapter II treats of "Zoölogical Classification," and following these is a rapid survey of the animal kingdom, fully illustrated by woodcuts, which, in the majority of cases, were used in the first edition of this work, published in 1869. Some of the cuts are exceedingly poor, though in the main correct. Fossil forms are presented with the recent forms as they should be, and so one gets a better idea of the range of the animal kingdom. It is a book that the amateur collector and the young zoölogist should have, as much information in a condensed form is embodied in its pages.

It might be expected that the book would be conservative and somewhat antiquated, from the known antagonism of its author to the modern views of derivation. It is interesting to see, however, that the leaven of evolution is working slowly but surely even here.

In the preface to the first edition, Sir William says: "I have avoided the modern doctrines of a 'physical basis of life,' and of 'derivation,' because I believe them to rest on grounds very different from true science, and therefore to be unsuitable for the purposes of a text-book." Having in the first edition arranged his material rigidly under the branches of Cuvier, he says: "I have not scrupled to adhere to them, as the expression of a grand and philosophical idea, essential to an accurate and enlarged conception of Nature"; and, again: "This fourfold division includes the whole animal kingdom, and is the only rational one which can be based on type or plan of structure. . . . The attempts which have been made to introduce additional branches or provinces I regard as retrograde steps; such, for example, is the province Cœlenterata of Leuckart," etc., etc. And now in sixteen years—a long time, it is true, for most minds to admit so much—we find the author not only cancelling his protests against a physical basis of life and derivation, but reluctantly taking the retrograde steps in adopting essentially the classification of Leuckart, Cœlenterates and all, though he turns back longingly to the quatenary classification of Cuvier, which he says may still be regarded as of scientific value.

May many active years of work be vouchsafed to this delightful and charming naturalist, and in these years may he prepare another edition of his hand-book, with still further omissions and admissions!

An Elementary Course in Practical Zoölogy. By Buel P. Colton. Boston: D. C. Heath & Co. Pp. 185. Price, 85 cents.

Mr. Colton has produced an admirable book in the one before us. A student will certainly get a clear idea of the animal kingdom if he follows the stimulating advice and directions which the book offers. The following plan of study is carried out:

1. Directions are given for collecting and preserving the specimens.

2. The live animal is studied.

3. The external features are noted.

4. The animal is dissected.

5. The development of a few forms is traced.

6. After studying each animal, its relations to other animals are considered (classification).

He has avoided the almost universal practice, so common in English and most American text-books, of commencing with the lowest known forms of life, and following up step by step to the highest, thus unavoidably conveying the false idea of a continuous ladder in creation. On the contrary, he commences his examinations with the insects as being animals that every one may easily get. The pupil is told how to see and what to see, and is permitted to express himself in his own words. Suggestive inquiries are made which make the student and teacher companions in the work of study and investigation. A good text-book requires a good instructor, and this book is no exception to the rule.

In the usual courses of study in the schools of this country, the teacher has some knowledge of the subject; that is to say, he can pass some sort of an examination in algebra, geometry, rhetoric, and similar studies, or, at least, it is assumed he can; but we venture the assertion that not one teacher in a hundred, into whose hands text-books of zoölogy are placed, could tell whether a spider had six legs or eight, or whether it breathed through its mouth or otherwise.

This book, most excellent in its plan and execution, will probably be in the hands of every intelligent teacher of zoölogy, while the ordinary school boards will probably impose the short six-foot cuts across-lots, in preference to longer and more instructive paths. This is not a supposititious case, for some years ago, a gentleman interested in the publications of D. Appleton & Co., on visiting a certain high-school in Indiana, was gratified to find the blackboards covered with drawings copied from Morse's "First Book of Zoölogy." On inquiry, he found that the teacher alone possessed a copy, from which he was really teaching, while the school board had introduced another book which the entire class possessed, and from which they were reciting, parrot-like, the lessons!

Peabody Museum of American Archæology and Ethnology, Eighteenth and Nineteenth Annual Reports. Cambridge, Mass. Pp. 124.

The nineteenth report is dated April 9, 1886. The interest of the document centers in the report of the Curator of the Museum, in which are recorded investigations made under the direction or with the co-operation of the Museum in various parts of the United States and in Central America. The investigations to which the most attention has been directed were conducted in Ohio, chiefly in the mounds of the Little Miami Valley. A brief exploration was made among the mounds near Chillicothe, and furnished relics forming an important link connecting the people who built the earthworks in the Scioto Valley with the builders of the singular group on the Turner farm in the Little Miami Valley. In the latter region several small mounds and a part of a large cemetery were explored under the direction of Dr. Metz. From the cemetery, which is across the river from the ancient cemetery near Madisonville, many thousand specimens, and many skeletons were obtained. For the first time the large pipes cut in stone in the form of human figures have been found associated with the skeletons—a discovery which connects these articles, hitherto only casually found on the surface of the ground with the people who used them, and which, with other circumstances, throws light on the burial ceremonies of those people. Examinations were made of some mounds on the bluffs of the Mississippi, in Pike County, Illinois, and less thorough ones of mounds in Calhoun County, on the Illinois River, from the results of which the interesting conclusions were drawn that the two sets of mounds were not built by the same people; and that "the burial-mounds of the Illinois bluffs resemble in contents, size, and structure the simple burial-mounds of the Ohio Valley, while those on the Mississippi bluffs have nothing in common with them except that they are burial-mounds." A special paper is given to an account of the exploration of the "Marriott Mound," in the Little Miami Valley, and the description of its contents; and a paper by Dr. W. F. Whitney, "On the Anomalies, Injuries, and Diseases of the Bones of the Native Races of North America." Accounts are given of the discovery of human bones in mounds near Trempealeau, Wisconsin; of Dr. Abbott's continued investigations in the Trenton gravels; of the explorations of shell-heaps in Maine; and of Miss Fletcher's studies of living Indian customs among the Omahas, and her gift to the Museum of the objects which those Indians had carefully preserved for many generations in their Sacred Tent of War." From Dr. Flint, in Nicaragua, have been received four blocks of tufa bearing human foot-prints, which were found under several layers of volcanic material, on the shores of Lake Managua; and several ornaments of jadeite, precisely like the Chinese jadeite. The later of the two reports contains some interesting references to the history of the Museum and its foundation, the growth of the collections and their arrangement in the cases. The entries in the catalogue of the collections have reached the number 38,840; but this gives no index to the actual number of objects; for the entries refer to sets as well as to single objects, and one entry may often stand for many objects.

The Earth's Annular System; or, the Story of the Rocks. By G. N. Vail, Barnesville, Ohio. Published by the Author. Pp. 400. Price, $2.

Professor Vail propounds a new theory of the formation of the earth and the origin of the geological systems. It is in effect an adaptation of the nebular hypothesis, and supposes that a large part of the matter that now forms the crust of the earth, together with the waters, was held in suspension through the ages, in the form of vaporous rings, and, as the vapors gradually cooled and condensed, the rings fell to the earth by virtue of the laws of gravity. These successive downfalls mark the various ages, periods, and epochs into which geologists divide the history of the earth's crust, Jupiter and Saturn are cited in support of the theory as planets which are still going through this process. The author believes that he is able by the application of his theory to explain such obscure matters as the numerous floods which geologists assert have fallen upon the earth; the absence of the rainbow previous to the Noachian deluge, and many other statements in Genesis; "dust-showers"; the rise and fall of vast areas of the earth's surface, changes by denudation, etc.; the apparent retardation of the moon; the "great ice age"; the origin of the limestone strata; and the origin of coal. He asserts that he is a practical geologist who has made his studies in the field, and has drawn his conclusions from them.

Diseases of the Digestive Organs in Infancy and Childhood. By Louis Starr, M. D. Philadelphia: P. Blakiston, Son & Co. Pp. 385. Price, $2.50.

The author's object in this book is to give prominence to a class of disorders which, while they are very usual in childhood, are yet too briefly considered in medical works. He regards the clinical investigation of disease in children as in some respects easier than the same study in adults. It is not complicated by circumstances of past life, yet there are very grave difficulties to be encountered in it, arising out of the sufferer's inability to give an accurate, or any, description of his feelings; and another source of embarrassment lies in the rapid growth and development of infants and the suddenness of their attacks, and the violence of the symptoms. Hence, the clinical investigation involves the three items of questioning the attendant for that which the child can not tell, inspecting the child, and physical examination. The importance of giving attention to the general regimen is particularly insisted upon. "So much may be done by the selection of suitable food, by artificial digestion, by regulating the clothing, bathing, and other elements of hygiene," that this factor is regarded as quite as important as the administration of drugs.

A History of the French Revolution. By H. Morse Stephens. In three volumes. Vol. I. New York: Charles Scribner's Sons. Pp. 533. Price, $2.50.

Mr. Stephens presents, as the valid reason for producing a new history of the French Revolution, the fact that a very large amount of new material has recently been brought to light, embodying many facts before unknown, and presenting other facts in a new aspect, which the great historians and the more popular ones following them did not possess, and therefore did not use. In other respects, he claims to be animated by a great enthusiasm for his subject, and believes it to be the most fascinating in its interest and the most valuable for its political lessons in the history of the world; that he has worked at it diligently for years, to the exclusion of everything else, and has striven to be impartial in his treatment of it. The new matter of which Mr. Stephens has been able to avail himself is, as he describes it in the preface, copious and varied. It comprises local histories, which have been published in considerable profusion, with histories of special periods and even days, and articles in magazines and reviews and the bulletins of local archæological and historical societies and academies; biographies of the great personages of the Revolution; memoirs on the relations between France and Europe during the revolutionary period, or what may be called the foreign policy of the Revolution; and the publication of documents. The author traces a bond of connection of the Revolution with America, for, "without the successful termination of the American War of Independence, it may be doubted whether the French Revolution would have developed as it did, or whether it would have taken place at all." We have still another community of interest in the subject, for "nearly every expedient, whether socialistic or purely democratic, which has been proposed of recent years for benefiting the condition of the people, was tried between 1789 and 1799, and if history has any value at all, it is this period which ought to be examined before any other, in order to learn the political lessons which it teaches."

The Pedigree of Disease. By Jonathan Hutchinson, F. R. S. New York: William Wood & Co. Pp. 113. Price, $1.25.

This volume includes six lectures on temperament, idiosyncrasy, and diathesis, which were delivered in the theatre of the Royal College of Surgeons. The author starts out by deducing from the examination of the facts supposed to indicate temperament, the conclusion that part of those facts are merely the characteristics of different races, and another part merely the products of past disease—personal or inherited; so that, giving these what belongs to them, there is little left of it. Idiosyncrasy is defined as a peculiarity of constitution in some one particular feature developed to an excessive height or "individuality run mad." As here treated, it concerns special liability to certain diseases or to peculiar affections from particular kinds of food or drugs. Diathesis is the same in a less definite and rather vague form. In the discussion of it the author considers three great universal diatheses dependent upon the very commonest causes of disease by which man and other beings have been assailed from primeval times—the catarrhal, the rheumatic, and the scrofulous. Close to these are others of less importance but of parallel nature, and comprising all within range of liability—those of senile degradation and malignant new growths (cancer). Following these are other important diatheses, widely spread but not universal, since they depend upon local exposure; while hesitation is expressed whether the malarial diathesis ought not to be regarded as primary or universal. These views involve the recognition of the doctrine of hereditary transmission, and indicate that we ought to study disease as being, not of recent origin, or in dependence solely upon existing influences, but rather as that in which many seek truthfully to "read the record of a long descent."

Outlines of Lectures on Physiology. By T. Wesley Mills. Montreal: W. Drysdale & Co. Pp. 200. Price, $1.

The author of this book is Professor of Physiology in McGill University, Montreal. The "Outlines" consist of the simplest and briefest statements of the principles of the science, such as might have served for the notes out of which the fuller lectures were elaborated. They appear to cover the whole field in its several departments, and to be adapted to give to the student who masters them such command of the subjects as books can afford, and to guide him in his experiments. An introductory chapter on general biology, and an appendix containing laboratory exercises in practical physiology, are also given.

Elementary Politics. By Thomas Raleigh. London: Henry Frowde. Pp. 163. Price, 25 cents.

Accepting the observation which some one has made, that "if men would only define the terms which they use in argument, most controversies would end before they begin," Mr. Raleigh has attempted in this useful little book to define the terms which are commonly used in political argument. The book is not meant to be a compendium of information, nor a summary of orthodox political doctrine; "not to satisfy but to stimulate inquiry"; not to form the reader's opinions, but to induce him to form opinions of his own. The chapter headings under which the definitions are given are, "The Origin of Society," "Primitive Society," "Civilization," "Modern Society," "The Modern State," "The Constitution of a State," "Elections," "Political Ideals," "Parties and Party Government," "Wealth, its Production and Exchange"; "Competition, Monopoly, Rent"; "The Distribution of Wealth," "Social Inequalities," "The Functions of the State," and "The State and Social Reform."

How to Strengthen the Memory. By M. L. Holbrook, M. D. New York: M. L. Holbrook & Co. Pp. 152. Price, $1.

This book has grown out of the author's own experiences and observations. It aims rather to determine the principles upon which the memory may be cultivated and improved than to develop a new system of mnemonics, the use of which, it is justly observed, "is like employing a large amount of machinery to accomplish a small amount of work." The principles which are set forth as fundamental to the cultivation sought, are the laws of association, comparison, attention, repetition, and the securing of a vivid first impression. These being observed, minor details will easily be learned. "Those who wish to possess memories of great power," the author remarks, "and become able to master the most difficult subjects, if Nature has not given them the requisite ability, can do so by hard work, and by no other means. All will find that the rational methods of memory culture advised will not only strengthen this faculty, but every other intellectual faculty."

The Hygiene of the Vocal Organs. By Morell Mackenzie, M. D. London and New York: Macmillan & Co. Pp. 223. Price, $1.50.

This volume is designed to be a practical hand-book for singers and speakers. The author has been engaged in the treatment of diseased throats for a quarter of a century, and asserts that every singer or actor of note in England, with hardly an exception, at one time or another, came under his hands. He believes, therefore, that he has had unusual opportunities for studying the conditions which affect the voice. An understanding of the relation of the vocal organs to the general economy is insisted upon as an essential prerequisite to all proper training of the voice. "Singers and speakers," it is remarked, "are not only artists but also in a certain degree athletes, their work consisting essentially in well-ordered muscular movements. A man may be trained for a foot-race or a boxing-match by methods which, while calculated to develop the special qualities required for the performance of the feat, may be simply disastrous to the health of the body as a whole. In like manner an unintelligent teacher may seek to develop the voice at the expense of its owner's constitution." Some knowledge of the elementary laws of health is therefore an indispensable part in the equipment of the vocal instructor.

Ten Dollars Enough. By Catherine Owen. Boston and New York: Houghton, Mifflin & Co. Pp. 279. Price, $1.

It was a novel idea to throw a treatise on housekeeping, with receipts for preparing the dishes to be served at dinner, etc., into the form of a story, but the author has done it, as she desires to have the housekeeping she teaches executed, well. That is, she has told an entertaining story, and has packed it with practical receipts for cheap, appetizing dishes. The purpose of the book, as declared in the sub-title, is to show how keeping house has been done well on ten dollars a week, and how it may be done again. The prices of provisions quoted are ordinary New York prices, and for the articles in their season. The heroine "was keeping house with some luxury, on the same amount of table-money as many require to live very plainly. This could not be done except by buying everything only in its season; if beyond a certain price, she waited for it to get lower." A housekeeper who has read the book with care, declares that the author deserves a vote of thanks for the service she has rendered in it to good and cheap living.

A Hand-Book of Hygiene and Sanitary Science. By George Wilson. Philadelphia: Blakiston, Son & Co. Pp. 520. Price, $2.75.

This is the sixth edition of Dr. Wilson's valuable manual. The scope of the book is public hygiene, and having this in view, and to prevent the volume from growing to too large a size with the additions that have been made to it, along with matter that has become obsolete, some subjects appertaining to domestic hygiene have been omitted, or rather transferred to a supplementary work. After the definitions and the historical introduction, the subject is considered under the general headings of "Food"; "Air, its Impurities, and their Effects on Public Health"; "Ventilation and Warming"; "Water"; "Water Analysis"; "Impure Water, and its Effects on Public Health"; "Dwellings"; "Hospitals"; "Removal of Sewage"; "Purification and Utilization of Sewage"; "Soils and Localities—their Influence on Public Health"; "Infectious Diseases—their Mode of Propagation and Prevention"; "Disinfectants and Disinfection"; "Vital Statistics"; and the "Duties of Medical Officers of Health." In addition to what was contained in former editions, there have been given in the section on the examination of food, brief descriptions of diseases which render the flesh of animals unfit to be eaten; new matter on water analysis and the analysis of sewage and effluents; the chapter on soils and localities and their influence on health is new; the chapter on infectious diseases has been remodeled; and subjects relating to disinfection are treated more fully.

The Student's Hand-Book of Historical Geology. By A. J. Jukes-Browne. London: George Bell and Sons; New York: Scribner & Welford. Pp. 597.

Dr. Jukes-Browne, having already published a volume on physical and structural geology, the present treatise, on paleontological and historical geology, is given to complete the student's curriculum. It pre-eminently concerns British geology, and is intended to present the history of the rocks of the British Islands, while Continental geology is drawn upon, in a supplementary way, only so much as is necessary to fill up the gaps in the British records and complete the outline of the history. Prominence has been given to such stratigraphical facts as throw light on the physical and geographical conditions under which each group or system of rocks has been accumulated; but in this department, where so much room is left for the imagination to work and there is so much temptation to give it freedom, the author has endeavored to confine himself to such inferences as might reasonably be deduced from a study of the facts. Illustrations are given representing typical fossils and sections of country, and they are clearly engraved.

The Buchholz Family. By Julius Stinde. Translated by Dora Schmitz. New York: Charles Scribner's Sons. Pp. 262.

This series of "Sketches of Berlin Life" is one of the most popular and one of the most amusing books ever published in Germany; a fact which is partly indicated by the mention in the title-page that the translation is made from the forty-ninth edition of the German original, while the story is only two years old. The heroine, Frau Buchholz, tells her own story of the troubles she got into by her intermeddling and jealousy, revealing in every incident how that she is the blunderer and to blame for all that is disagreeable, yet always totally unconscious that her conduct has not been marked by strict propriety and perfect tact. As a picture of German middle-class vanity and the weaknesses that attend it, the story has rarely been excelled; yet it is all told in perfect good-humor, with the most evident fidelity to nature, without exaggeration or malice. The translation is usually done with grace and spirit.

A Manual of Lithology. By Edward H. Williams, Jr. New York: John Wiley and Sons. Pp. 135. Price, $1.25.

The author is Professor of Mining Engineering and Geology in Lehigh University. In the classes, after thorough grounding in crystallography and mineralogy, the student begins the study of rock-formation. The theory and definitions are first acquired, and afterward a practical knowledge of the rocks is obtained by the examination of specimens. The object being to enable the student to classify at sight the more common species, only the macroscopic peculiarities are given. Mr. Williams has sought in this manual to combine a thorough knowledge of the elementary portion of the subject, with a brief account of the principal rocks, and a ready method for their determination.

Mineral Springs of the United States. By A. C. Peale, M. D. Washington: Government Printing-Office. Pp. 235. Price, 20 cents.

This paper is published as "Bulletin" No. 32 of the United States Geological Survey. The author's first effort was to obtain a list of the springs. All previously existing lists were found to be incomplete. The fullest one—that of a committee of the American Medical Association, referred to as "Pepper's List"—gave about 500 localities of springs. Others described, respectively, 171, 181, and 173 localities. The present lists include 2,822 localities, more than 600 of which are places of resort, and more than 200 sell the waters. Yet they are not regarded as complete, but only as preliminary to more detailed work which it is hoped may follow in the future. The information has been derived primarily from State geological reports and maps, various scientific publications, and members of the Geological Survey who have had opportunities of visiting different parts of the country. The results of analyses are given, where analyses have been made.

PUBLICATIONS RECEIVED.

Deist, R. Scraps of Philosophy for Skeptics. Knoxville, Tenn.: Zuberbuehler. Pp. 48. 25 cents.

Scudder, M. L. The Labor Value Fallacy. Chicago: The Patriots' League. Pp. 112. 10 cents.

Chicago Manual Training-School. Fourth Annual Catalogue, pp. 16.

McPherson, S. J. Hand-Culture and Character. Chicago Manual Training-School. Pp. 23.

Gladstone on the New Locksley Hall. New York: Brentano Bros. Pp. 39. 25 cents.

Walcott, Charles D. Second Contribution to the Studies on the Cambrian Faunas of North America. Washington: Government Printing-Office. Pp. 369.

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POPULAR MISCELLANY.

The Origin of Languages.—Mr. Horatio Hale, in his address at the American Association, on "The Origin of Languages and the Antiquity of Speaking Man," reviewed the theories that have been offered on the former title of his subject, and declared them all unsatisfactory; for none of them can be made to account adequately and consistently for the number and diversities of the languages that prevail among men. And yet, he declares—and confirms his assertion with evidence that seems almost as clear as it is novel and interesting—that while some of the ablest reasoners have thus been groping vaguely and blindly, in wrong directions, for the solution of this problem, and while others have given it up in despair, "the simple and sufficient explanation has been lying close at hand, awaiting only, like many other discoveries in science, the observation of some facts of common occurrence to bring it to light." It is derived from two sets of observations, dating from nearly twenty years ago, which were published, one in 1868, and the other some ten years later, without attracting much attention. But they proved full of suggestion to the author, and led him to the conclusion, to which they seemed to point with irresistible force, "that the origin of linguistic stock is to be found in what may be termed the language-making instinct of very young children. From numerous cases, of which the history has been traced, it appears that, when two children, who are just beginning to speak, are left much together, they sometimes invent a complete language, sufficient for all purposes of mutual intercourse, and yet totally unintelligible to their parents and others about them." One of the observations was published by Miss E. H. Watson, of Boston, in 1878, and related to two children, twin-boys, in a suburb of Boston, who at the usual age, as she tells the story, "began to talk, but strange to say, not their 'mother-tongue.' They had a language of their own, and no pains could induce them to speak anything else. It was in vain that a little sister, five years older than they, tried to make them speak their *native language* as it would have been. They persistently refused to utter a syllable of English. Not even the usual first words, 'papa,' 'mamma,' 'father,' 'mother,' it is said, did they ever speak; and . . . they were never known during this interval to call their mother by that name. They had their own name for her, but never the English." While they had the usual affections for their parents, etc., they seemed to be otherwise completely taken up and absorbed with each other. "The children had not yet been to school; for, not being able to speak their 'own English,' it seemed impossible to send them from home. They thus passed the days, playing and talking together in their own speech, with all the liveliness and volubility of common children." They had regular words, and "even in that early stage, the language was complete and full; that is, it was all that was needed." Finally, there seeming to be no hope that they were going to learn "their own tongue," it was concluded, when they were six or seven years old, to send them to school. "For a week," as the lady teacher described, to whom they were sent, "they were perfectly mute; not a sound could be heard from them, but they sat with their eyes intently fixed upon the children, seeming to be watching their every motion—and, no doubt, listening to every sound. At the end of that time they were induced to utter some words, and gradually and naturally they began, for the first time, to learn their 'native English.' With this accomplishment, the other began, also naturally, to fade away, until the memory, with the use of it, passed from their minds."

Miss Watson did not become acquainted with these facts till it was too late to preserve a record of the language itself; but in the other case, a part of the language was preserved by a careful and scientific observer. This case occurred in Albany, New York, and was described, by Dr. E. R. Hun, in the "Monthly Journal of Psychological Medicine" in 1868. A little girl four and a half years old, the sprightly and intelligent child of cultivated parents, had been observed, when two years old, to be backward in speaking, "and only used the words 'papa' and 'mamma.' After that she began to use words of her own invention, and though she understood readily what was said, never employed the words used by others. Gradually she enlarged her vocabulary. . . . She has a brother eighteen months younger than herself, who has learned her language, so that they talk freely together. He, however, seems to have adopted it only because he has more intercourse with her than with others; and in some instances he will use a proper word with his mother, and his sister's word with her. She, however, persists in using only her own words, though her parents, who are uneasy about her peculiarity of speech, make great efforts to induce her to use proper words." Dr. Hun followed up this general description of the language with analyses of some of its words and other features. These two recorded instances of child-languages led Mr. Hale to further inquiries, which, though brief and limited, showed him that cases of the sort are by no means uncommon, and he cites a few other instances. In the light of the facts thus set forth, it becomes evident, says Mr. Hale, "that, to insure the creation of a speech which shall be the parent of a new linguistic stock, all that is needed is that two or more children should be placed by themselves in a condition where they will be entirely, or in a large degree, free from the presence and influence of their elders. They must, of course, continue in this condition long enough to grow up, to form a household, and to have descendants to whom they can communicate their new speech. We have only to inquire under what circumstances an occurrence of this nature can be expected to take place."

A Correction.—We find the following in "Science" of January 21st:

Popular science.—It is often very popular indeed. Here is an article on the voices of animals by Detler von Geyern (whoever he is), from *Ueber Land und Meer*, translated for the *Popular Science Monthly*, January, 1887, written in the good old traditional vein, quoting what anybody has said on the subject in a wonder-mongering way, as if every thing said and written must be true. And Herr von Geyern himself says, "Fish can produce no sound in water, because air is lacking as a medium to propagate the waves of sound; and yet we incline to the belief that water itself may admit of forming some kind of sound-waves which the fish may be capable of exciting, and which will be experienced and comprehended by other fish;" and he adds, "As far as we are concerned, of course, fish will remain mute," etc.—as if between fifty and a hundred species of fish are not known to make sounds, many of which have been described and explained by naturalists; and as if water and every other elastic medium were not well known as propagators of sound, often better than air,—a fact familiar to boys, who hold their heads under water, while bathing, to hear the loud sound made by the striking-together of two stones under water in the hands of a companion at a little distance.

H. W. P.

Grinnell, Io., Jan. 14.

We very much regret that an error so obvious as the above should have escaped attention in the revision of the article in question; but we do not pretend to be infallible. The paper was accepted on its general merits as a bit of pleasant reading; and coming to us from an outside source, it could not receive that critical attention to every detail which our own translator is compelled, by the nature of the case, to give to each item of his work.

Self-Purification of Water.—F. Emich has carried out a series of experiments on the behavior of water when allowed to stand exposed to the air, and also when shaken up with air. He has further experimented with sterilized water, and on the behavior of waters submitted to the action of ozone and hydrogen peroxide. The self-purification of water, or the destruction of its organic and inorganic impurities, may be the consequence, either of a purely chemical process (oxidation), or of a biological process. It appears that, on exposure to or agitation with air, the self-purification takes place only if the water has not been previously sterilized by boiling, and protected afterward against the entrance of germs. But if a sterilized water has been subsequently exposed to the air or mixed with ordinary water, it undergoes the same changes as waters that have not been sterilized; its oxidizable power and its ammonia decrease, while nitrous or nitric acid is formed. If, therefore, the development of organisms in the water is rendered impossible, self-purification is also impossible. Direct oxidation by atmospheric oxygen certainly does not take place; and, if ozone and hydrogen peroxide play a part, it is a subordinate one. The kind of living beings which effect the purification of waters will differ greatly according to circumstances. Such a change of species has actually been observed in one and the same water-course in the different stages of its pollution. Self-purification may take place, even when industrial refuse is allowed to flow into the water in addition to organic pollution. Dr. J. Soyka has made experiments on the power of the soil to absorb poisonous substances and destroy them; and has showed it to exist in the cases of strychnine and a considerable number of the organic alkaloids. His experiments have not been extended to the ptomaines. Nevertheless, we must beware of supposing that the treatment of foul waters can safely be left to Nature. Where the supply of polluting matter is continuous in time and space, natural purifying agencies fail. An important lesson to be learned from the researches of Emich and Soyka is, that the microbes, both of earth and water, are not all to be regarded as disease-generators. On the contrary, certain kinds of them are converting malignant matter into forms in which it is harmless, or even useful. Hence, it is at least possible that, in the application of disinfectants or "germicides," there is room for discretion.

School Life and Health.—Dr. Thomas Whiteside Hine, of Bradford, England, has made inquiries into the effect of school life upon the mortality of children, taking as the basis of his conclusions the reports of deaths among children of from five to fifteen years old, persons of that range of ages being regarded as probably those upon whom the effects of school life and work would be most marked. Comparing the returns from 1871 to 1880 with those from 1861 to 1870, he finds that while the mortality of children from all causes and from zymotic diseases—on which school influences are negative—has considerably diminished, their mortality from nervous diseases—the direction in which school influences would be most felt—has exceptionally remained stationary. To this he adds that the figures for 1881 and 1882 likewise show identical results in both instances. Further than this, he finds that there has been an improvement in the death-rate from nervous affections among children below five years, who are out of school, or have been in it for only a short time. Yet the whole of the mischief must not be attributed to the effect of schooling alone; but, as all the world lives faster than it did, the nervous system of children is likewise stimulated at the present day to an extent unknown a generation ago, and greatly to their disadvantage. The existence of such sources of mischief in the habits of the day supplies a strong reason why all school influences calculated to enhance the mischief should be removed.

Seasoning Timber.—Of the common sense of the question of seasoning timber, Mr. Thomas Blashill says, in an address on the general subject: "Wood must not be dried so quickly that it will be made unsound by cracks. It must not be dried so much that it will absorb fresh moisture when it comes into the atmosphere in which it has permanently to remain. It is not merely a question of time, but of judgment, the objects being to see that the timber is gradually reduced in scantling as it dries, and so treated in temperature and stacking that it neither splits nor gets out of shape. . . . To sum up the whole class of questions connected with seasoning, we want timber that will not shrink after it is brought into use, that will not work or twist out of shape, will not decay through damp, and will not be destroyed by insects. Wood may also be indurated, that being the result of polishing and of varnishing to some extent. Upon the whole, it is desirable to encourage all means of treating wood so that it may possess some of the advantages that are commonly attributed to iron and stone. In cutting up timber for use, the question of its grain as developed by the annual rings is of very great importance. The shrinkage being greater in the newer layers of wood, it must be cut so that this irregular shrinkage may be of no disadvantage." In oak, in order to show the beauty of the grain, as well as to provide wainscot-boards that will be true in shape, it is necessary to get the boards as far as possible to radiate from the center to the outside of the log. If this is done, the medullary rays are cut through in many places, so as to show the silver grain. Ash-timber does not appear to have any sap-wood, all the wood being of the same color; and there are foreign woods with the same peculiarity. But the worm finds out the part that is sap-wood. In elm-timber the sap is reckoned as good as the heart. The timber does not improve by seasoning, but should be used green, and even kept wet until wanted for use. When used in flooring, the oldest elm boards have been known to shrink considerably, if they were merely taken up and planed.

Stanley Jevons on Mathematics and Meteorology.—Professor Jevons wrote to his sister, June 17, 1857: "I have never had the courage to open the many mathematical books I brought with me; but what do you think I would do if I had opportunity ever again? Attend college and De Morgan's mathematical lectures! The utility of mathematics is one of the most incomprehensible things about it; but though I was never bright or successful in his class, in spite of working hard, I feel the greatest benefit from it. Mathematics are like the calisthenic exercises of the mind, and make it vigorous and correct in form and action; but it depends, of course, on other circumstances how you apply and use your mind as well as your body. To go figuring about with your arms or legs is not the object of calisthenics. I think, therefore, you can not waste time or trouble spent over mathematics—the more the better, for the present at all events. . . . I do not mean you to enter on the study of meteorology, for it is a most troublesome, extensive, and to most an uninteresting subject. I have, however, involved myself in it to an awful extent, and must go on with it, I suppose, while I am here [in Australia, engaged in the Mint at Sydney, and furnishing weekly reports to the 'Empire']. It is a most complicated subject, requiring a knowledge more or less of heat, light, chemistry, electricity, etc.; and is, therefore, a sort of difficult scientific exercise rather than a science itself."

A Legend of Monkeys and Stones.—Prince Carl, of Sweden and Norway, when starting out from Hyderabad, India, on a tiger-hunt in 1883, was struck by the scenery around the city, where the undulating ground is strewed with huge blocks of stone, "as if they had been tossed hither and thither by Nature in some capricious mood. Some of the blocks are piled upon each other in such a manner as to cause a lively imagination to fancy them giants and trolls barring the way. According to Indian folk-lore, these blocks were brought hither, some four thousand years ago, in this manner: The monkeys, which in the earliest of times in great numbers inhabited the lands beyond the Himalayas, seized on the remarkable idea of building a bridge between the mainland and Ceylon, and, headed by their leaders, they left their settlements in great numbers for the south, carrying with them from their mountains materials for their gigantic bridge. But the road became too long for them, and they were obliged, on reaching the spot where Hyderabad now stands, to throw their loads away, and here they lie to-day."

Jade Ornaments in America.—At a recent meeting of the American Antiquarian Society, Mr. Frederick W. Putnam exhibited a collection of celts, axes, and ornaments made of various stones known under the general term of jade. They were from various places; and among them were one with a cutting edge at each end, and twelve specimens from Nicaragua and Costa Rica. Of the twelve, ten were ornaments which had been made by cutting celts into halves, quarters, or thirds, and on each of which a part of the cutting edge of the celt remained. One of the ornaments had been compared by Professor Cooke with a cup of jadeite from China, and found to be like it in color, hardness, and specific gravity. The mineral jade, or jadeite—which varies in color from almost milk-white, with a slight shade of green, to a beautiful emerald-green—has not been found in place in America. So far as is known, all the varieties come from Asia. That it was rare, and regarded of great value among these Central American people, is shown by the fact that they wrought it into finished ornaments with such care, and that to make those ornaments they cut up celts already of value as useful manufactured articles, instead of using rough stones. The question is then in place, whether it is not reasonable to believe that the stone was brought from Asia in the form of implements by the early migrants to this country; and that, as the supply was not kept up, and most likely even its source became unknown, the pieces among the people were cut and recut, and preserved as sacred relics of the past, to be, one after the other, finally buried with their owners?

Oscillations of Italian Soil.—M. Quesnault read a paper, at the recent meeting of the French Association, on his researches into the oscillations of the ground and the movements of the sea. He had already laid some of his observations on the subject before the previons meeting of the Association, and they had been received with favor. He ascribed the changes of level which the ground undergoes to two very different causes: those of one character, sudden and transitory, were traceable to volcanic phenomena; others were attributable to sublunary and atmospheric influences. Those more general movements, which manifest themselves slowly and regularly either in depression or elevation, could be explained only on the supposition of an astronomical revolution of long duration not yet ascertained, that modifies the center of gravity of our planet and the motion of the waters that cover it. Professor Issel, of the University of Genoa, presented some valuable facts on the modifications of level, both slow and rapid, which the soil of Italy has undergone through a long series of years. Some of these facts, the result of slow and secular movements, are well worthy of attention. Thus, the Venetian estuary and Istria have been subject during historical times to a sensible depression which amounts at Venice to three or four centimetres in a century. The same movement is very evidently manifested on the coasts of Dalmatia, Albania, and Greece, and probably extends across the Mediterranean to Barbary and Egypt. Malta is or has been in the track of the depression. In Sicily, less evidently, Professor Issel takes notice of an elevation, which may have amounted to between four and six metres, since 400 B.C. A similar movement seems to have taken place on the Calabrian littoral opposite to Sicily; but this fact of elevation being common to nearly the whole of the Mediterranean basin, we are led to connect it with some astronomical phenomenon rather than with a change in the level of the sea. Professor Issel also remarks that, while we observe signs of recent depression at certain points of the Italian coasts, other evidences are plainly exhibited of a previous elevation (quaternary), which attained, in Liguria, a height of twenty metres.

Barometric Wells.—Some wells in Meyrin, Canton of Geneva, Switzerland, have barometric properties. They have been closed at the top, except for a small air-hole, and through this the wind blows in or out, according to the conditions of atmospheric pressure, sometimes with force enough to make a sound like that of a steam-whistle. If a hat or any light article be put over the hole when the barometer is falling, it will be blown up at once; but if the outer pressure is rising, the draught will bring leaves and other light objects toward the well. The people of the village understand the action of the wells, and make it their weather gauge. The origin of the phenomenon is easily explained. It is dependent upon the differences that may be produced at any time between the pressure of the air within the wells and that of the outer atmosphere.

Asafœtida.—The gum asafœtida is derived from an umbelliferous plant (*Ferula asafœtida*) which grows in Persia and Afghanistan and other parts of Central Asia. Some information regarding the preparation of the gum is given in Dr. Jaworsky's account of his travels in those regions, which was published during 1885. The author was given a whole plant, with root and stem, by a native, and found its odor penetrating enough. The stem is three or four feet high; the leaves are incised like those of other umbelliferous plants. The root is impregnated with the gum, which exudes wherever a cut is made, appearing of a light amber-color, hard consistency, and somewhat crystalline look. The root bears numerous side-roots, and is covered with a brown, scaly skin, crossed with rings. The plant grows in stony ground, blooms in the spring-time, and is propagated from the seeds. The gum is not collected from the roots till the plant is fifteen years old. At that time the stalk is cut off after the plant has blossomed and the seed has ripened. In a day or two afterward there exudes a thick, creamy, whitish juice, that soon becomes brown and hard. In about twelve days the amber-colored gum is taken off. A new cut is then made in the plant, and another "crop" of gum collected; and the operation may be repeated, if the season is favorable, six or eight times in a single summer. But the returns from the later cuttings are inferior to those from the first. A single root may furnish from a half pound to a pound of the gum in a season. Rain spoils the gum, and if it happens to be wet during the time of collecting, the crop for that year will have to be written down a failure. The plant that has been once operated upon is left to itself for ten or twelve years, when it becomes available for another crop.

Brain-Volume and Intelligence.—Dr. Adolph Bloch has published in the "Revue d'Anthropologie" a memoir on the relations existing between intelligence and the volume of the brain in man. He concludes that there is no absolute relation, for very intelligent persons may have a small brain, and individuals of very mediocre capacity a large one. We may also find among some races which are not considered very intelligent a brain or cranial capacity of relatively considerable amplitude. The conditions, moreover, which make the brain to be larger or smaller are manifold. The volume of the encephalus may be related to the size, to the weight of the body, and to the muscular power; and the brain itself may become voluminous in the race and the individual according to the degree of intellectual activity. The most important factor in the degree of the intelligence of the individual is the quality of the cerebral cell; and that is determined by the greater or less impressionability or excitability of that structure regarded as the substratum of intelligence. This impressionability may be native or acquired. In the former case it is the mark of a superior intelligence; in the latter, it may be produced by such sustained labor as every man of genius is compelled to endure. It may also be developed by nervous disease. In a whole race, there are influences, not depending on the individual, but acting upon all that contribute to the perfection of intelligence and the selection of remarkable men. The kind and degree of intelligence are also variable according to races; but in no case can the volume of the brain alone constitute the principal factor of intelligence.

The Protection of Rare Species of Plants.—The Association for the Protection of Plants, at Geneva, Switzerland, Henry Correvon secretary, has issued a circular, setting forth its objects and inviting horticulturists and collectors to assist it in carrying them out. The circular alludes to the anxiety which naturalists feel lest some rare species may be extinguished through the operations of man; and others which but for the possession of unusual means of defense would be in danger of succumbing at once under an attack of more than ordinary vigor. Some species are approaching the term of their existence. Their end may be hastened by man, although he may perhaps not be able greatly to prolong their lives. Some plants are cultivated in modified forms as choice varieties, while the original stocks are neglected and allowed to die out; some, of foreign origin, live a kind of colonial existence in particular countries, and need care to preserve them there. Some are the objects of vigorous search by amateurs and horticulturists, who often pluck them recklessly without reflecting that the place where they are found may be the only spot in the country where they occur. The *Dracocephalum Austriacum* and *Dictamus fraxinella* have nearly disappeared from their native haunts. Plants like the *Paradisia lilia-*

strum, the *Anemone sulfurca* and the *Ranunculus glacialis* are taken from the Alps by ten thousand at a time; and a lot of four thousand edelweiss was recently shipped to America. If the plants are not taken up with proper care, eighty out of a hundred of them will probably perish, and fifty more will be trampled upon or mutilated in getting the hundred. The Swiss Association does not object to the collecting of the plants; it only wants them collected in such a manner that no danger shall be incurred of destroying or diminishing the species. It seeks to point out how this may be done, by selecting the season when removal will involve no danger to the life and vigor of the plant, and especially by insisting upon a more general adoption of cultivation and reproduction by seed. It has established a garden of acclimatation near Geneva, where the seeds of mountain-plants are raised to be sold at a moderate price, from which it has already obtained good results; for many persons who used to plunder the mountains now go to it for seeds. It does not confine its attention to the plants of its own country, but keeps a good lookout also for the well-being of rare species in other lands; and has agents in Mexico and Brazil to intercede with the authorities for the institution of measures to secure the preservation of the cactuses of the former country and the orchids of the latter.

Glacial Action in East Africa.—Mr. H. E. O'Neill, British consul at Mozambique, in a description of Eastern Africa, between the Zambesi and Rovuma Rivers, speaks of the frequency with which one encounters evidence of glacial action as a very interesting point to the traveler in that country. "I have met with it," he says, "upon the Namuli range, in the Inagu Hills, and again much nearer the coast, among a small block of hills called the Tugni. You see it everywhere in the smooth, dome-shaped tops and polished precipitous sides of the hills of the country, but the clearest evidence is afforded by the more striking spectacle of huge detached blocks lying across the summits of peaks—blocks many tons in weight, which could never have been carried there by any other known physical agency than that of ice."

Our Oldest Herbaria.—President William Carruthers, in the Biological Section of the British Association, spoke of the value of herbaria, or collections of dried specimens of plants, for supplying the most certain materials for the minute comparison at any future time of the then existing vegetation with that of our own day. We have now collections in England about two hundred years old that have been used for that purpose. Dr. Schweinfurth has obtained specimens, which were originally deposited in the form of offerings, from Egyptian tombs, four thousand years old, which are as satisfactory for the purposes of science as any collected at the present day, and which consequently supply means for the closest examination and comparison with their living representatives. The colors of the flowers are still present, even the most evanescent. The chlorophyl remains in the leaves, and the sugar in the pulp of the raisins. Dr. Schweinfurth has determined fifty-nine species, some of which are represented by fruits, others by flowers and leaves, and the remainder by branches. Mr. Carruthers also referred to the deposits discovered at Cromer, and the remains which exist of pre-glacial flora, and came to the conclusion that the various physical conditions that necessarily affected those species in their diffusion over such large areas of the earth's surface in the course of, say, two hundred and fifty thousand years, should have led to the production of many varieties, but the uniform testimony of the remains of this pre-glacial flora, so far as the materials admit of a comparison, is that no appreciable change has taken place.

Coal-Mine Gas-Explosions and the Weather.—Mr. H. Harries remarks, in "Iron," that though a connection is believed to exist between fire-damp in coal-mines and atmospheric changes, its nature is not well understood. The rule is probably analogous to that which controls weather-changes, which are not indicated by definite points in the barometric scale, but by differences in pressure between neighboring places. He thinks, therefore, that it is desirable to ascertain whether the presence of gas in mines is, like the weather, distributed in areas, and whether within those areas some localities would have more gas than others, according to the inequalities in the distribution of pressure. Mr. Harries invites officers in coal-mines to supply him with observations of the pressure of gas in their mines, taken once a day, in the morning—at least for the four months ending with December 31st. The information thus supplied will be compared with that furnished by the weather-charts for the same hours.

Disappearance of an Island.—According to the official newspaper of the Faroe Islands, the rock-island of Munken, south of Sumbö, which was one of the most prominent landmarks of the group, has sunk. It had stood seventy feet above the level of the sea, but several months ago a large proportion of the rock had crumbled away, so that the tide washed over most of its surface. The shallow waters around the island formed dangerous currents, with eddies, or maelstroms, which were much dreaded by mariners. Pastor Lucas Jacobsön Debes, in 1673, gave a graphic description of the maelstrom, with the Sumbö Munken rock rising from amid it, and asserted that the compass lost its polarity there. Pastor Jürgen Landt, in 1800, also wrote about the maelstrom, and described the island as presenting, when seen from the water, the appearance of a ship under full sail; and from the land, the likeness of a monk, having a neck of red clay, and a head and body of a dark-gray stone, or coarse basalt. On the 28th of May, 1885, the Danish Minister of the Marine reported that Munken had fallen in, and so one of the most striking objects in the Faroe group, which had been sailed past and admired by thousands of sailors, and played an important part in geographical literature, had disappeared.

Laterite and its Odors.—A writer in "Das Ausland" states that in a certain district of West Africa the soil is largely composed of an argillaceous deposit called laterite, which is very porous and freely penetrable by water to its lowest depth. As the water penetrates it, the air contained in it is of course driven out. This air being charged with decomposing organic matters washed in by the rain, the emanations after a strong shower are decidedly malodorous. As violent storms are not unfrequent, they are regular and strong enough to attract the attention of the natives, and they give them a name which may be translated meadow-stink.

NOTES.

The steel-plate portrait of the late editor of this magazine, published in the present number, is by Mr. Charles Schleet, and is considered by the friends of Professor Youmans a spirited and excellent likeness.

Mr. W. Stainton Moses, lately a vice-president, has withdrawn from the English Society for Psychical Research, on the ground that the evidence for phenomena of the genuine character of which he and others have satisfied themselves beyond a doubt, is not properly entertained or fairly treated by it.

Professor Burt G. Wilder looks forward to a time when the terms used in anatomy will be simplified and made to agree with a uniform standard. Replying to criticism of the modifications he has himself introduced in such terms, he claims to have endeavored to hasten what seemed to be the natural progress of reform. Very few terms used by him do not occur in the writings of some anatomist of authority. He has selected what seemed to him the best, modified them, when desirable, in accordance with established etymological rules, and has "always used the same word for the same thing." This he has done consistently and persistently; and whatever new terms he puts forth are first tested in the laboratory and lecture-room.

There is no doubt, the "Lancet" believes, that woman can, if she will, qualify herself to do anything that a man can do; for "no physiologist will question the possibility of developing by appropriate stimuli, exercise, and food, any particular part or parts of an organism in such a manner as to make it respond to the demands of its environment"; and it must therefore be theoretically possible that the woman shall be developed in respect to any one or more of her organic potentialities to a level with the male. But she must do so at the expense of some other power, and this is usually at the sacrifice of some function that makes her valuable as a woman. The real question in the matter is, whether it is worth while to pay so great a price for the privilege.

Fourteen European scholars in China recently had a discussion of the question whether Western knowledge, and particularly science, should be conveyed to the Chinese through the medium of their own or of a Western language. The general tendency of their views, which varied as to details, was in favor of exciting the curiosity and interest of intelligent Chinese in the matter of Western knowledge by popular expositions in the native tongue, reserving a more adequate representation for a time when a sufficient number of Chinese shall have acquired foreign languages to constitute a learned class in our sense of the expression. A further and final stage will be reached when the members of this class shall become the conveyers of knowledge to their countrymen in a vernacular improved and adapted to the comprehension of scientific ideas.

Mr. J. W. Walker has discovered a site on Pine Mountain, Georgia, where the ancient inhabitants of the region manufactured their talc vessels for cooking, with indubitable evidences of the use of stone implements in the work. Other similar sites have been found in the District of Columbia, and in Southern California.

Some doubt is thrown upon the "cavern theory" of the origin of minor earthquakes by the publication of Professor O'Reilly's catalogue of British earthquakes and its accompanying map. The data show that, during the period embraced in the view, Ireland has been less subject to earthquakes than England and Wales. In the face of this revelation is the fact that Ireland is remarkably and excessively undermined by cavernous formations, so that if they really give rise to earthquake-shocks, it should have suffered more from them than any other country represented.

A large group of mineral springs in the Transbaikal region of Russia have gained a high repute for their curative effects on men and animals. Their temperature ranges from 35° to more than 100° Fahr. Some are ferruginous, some alkaline, and others sulphurous in composition.

The slopes and environs of the volcanic mountains Etna and Vesuvius are and always have been famous for their fertility, by which large populations are tempted to live, where they are in constant danger of being destroyed by an eruption. The richness of the soil has been traced to fertilization by volcanic ashes, which have been determined to be remarkably rich in their phosphoric acid and potash constituents. Accounts from the district in New Zealand that was flooded with ashes by last June's eruption indicate likewise that the disaster there is likely to prove a "blessing in disguise."

Gold in quantities worthy of attention has been found in the neighborhood of St. Sebastian Bay, Terra del Fuego. It exists in little flakes and oval grains.

Professor W. Mattieu Williams observes that political economists condemn the precept of the Sermon on the Mount, which bids us take no heed of to-morrow, and acknowledges that it is in opposition to the established laws of our political economy. But, he asks, is our political economy a universal science, or is it only the economics of the temperate zone? The primary reason for the duty of thrift that is imposed on us is that in our latitude the earth only yields its fruits during a part of the year, and we have therefore to make stores of food and other material produced by annual harvests. In tropical countries, and to a certain extent in such sub-tropical regions as Palestine, there is little or no necessity to gather into barns, as it is there quite possible to have a daily harvest by arranging a suitable succession of crops.

A woman's journal—called "La Rassegna degli interessi femminili," or "Review of Feminine Interests"—has been started, under the direction of Fanny Zampini Salazaro. It will be adapted to Italian women of all ranks and stations in life, and, while it will not neglect the lighter matters, it proposes to give prominence to those things that are solid and will contribute to the economical well-being and mental development of its constituency. It will consider what relates to women's duties, work, and recreation, and the fields of activity that may be open to them. Domestic duties and the care and training of children will also have a place in it. "La Rassegna" will be published on the 15th of every month, in octavo form. The first number is before us. It is filled with matter of solid interest, and presents a very creditable appearance.

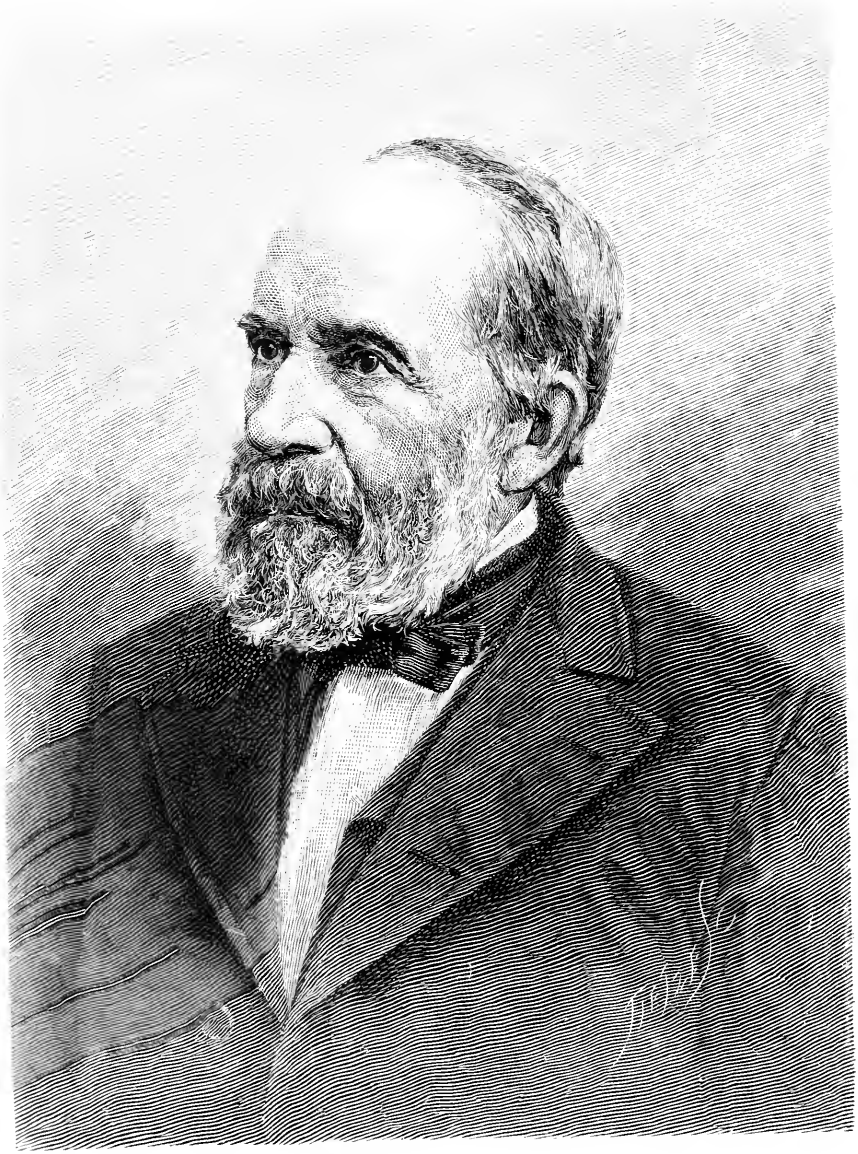
OBITUARY NOTES.

Mr. Jules Lichtenstein, whose name is associated with researches with regard to the phylloxera, is dead.

The death of Professor M. Websky, one of the most distinguished mineralogists in Germany, is reported.

Mrs. Thomas Say, widow of the eminent naturalist, died at Lexington, Massachusetts, November 15th.

Mr. Arthur Grote, author of many papers on subjects of natural history, died in London, December 4th. He was a brother of George Grote, author of the "History of Greece," and was born in 1814. He spent thirty-four years in the civil service in Bengal, where he was President of the Royal Agricultural Society of India, and of the Asiatic Society of Bengal. Returning to England in 1868, he became a prominent member of the Linnæan and Royal Asiatic Societies.



LEO LESQUEREUX.

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BRAIN-FORCING IN CHILDHOOD.*

By WILLIAM A. HAMMOND, M. D.

NOT very long ago a lady of this city brought her little daughter, twelve years of age, to see me professionally. The child was on her way to school, and had with her a large satchel full of books. She was pale, tall, and thin. The muscles of her face twitched convulsively, and she could not keep her hands and feet still. She was suffering from chorea, or St. Vitus's dance, and, in addition, had almost constant headache and other symptoms of nervous derangement. In the course of my examination I asked her to empty her satchel of the books it contained, and which, as she informed me, she had been studying that morning and the night before. This is the list:

1. An English grammar. 2. A scholar's companion. 3. An arithmetic. 4. A geography. 5. A history of the United States. 6. An elementary guide to astronomy. 7. A temperance physiology and hygiene (whatever that may be). 8. A method of learning French. 9. A French reading-book.

Nine in all—nine different subjects of knowledge which that poor child was required to study between the hours of three in the afternoon of one day and nine in the morning of the following day! Allowing one hour for dinner, half an hour for breakfast, an hour for undressing at night and dressing in the morning, an hour for going home and returning to school, and eight hours for sleep (and less than this will not suffice for a growing boy or girl—it had better be nine or ten), and we have six hours and a half left in which to study nine different branches of learning! Now, suppose either one of you ladies and gentlemen should retire to some quiet nook, and, with your well-developed and trained brains and experienced minds, should try to study nine unfamiliar subjects of knowledge in six hours and a half,

* An address delivered before the Nineteenth Century Club, January 25, 1887.

would you think it strange if at the end of that time you should somewhat mix matters, and imagine that Hong-Kong is the name of a lunar volcano, that the Continental Congress is one of the parts of speech, and that the ductus communis choledechus is situated on Passamaquoddy Bay? *She* showed no such confusion of ideas. She had studied her lessons well, but she had done so at the expense of her brain-substance. In a little while, and English grammar, geographies, and temperance physiologies, would have been like the "subsequent proceedings" in Bill Nye's poem; they would have "interested her no more." I say that she had learned her lessons at the expense of her brain-substance. This is no flower of speech, but a sober fact. A very simple examination enabled me to satisfy myself that she was living on her brain-capital instead of her brain-income. Her expenditures were greater than her receipts, and brain-bankruptcy was staring her in the face.

An instance like this, in which disease is directly the result of excessive use of the brain, is only one of the many that are constantly coming under the observation of physicians. It is not at all likely that any remarks of mine, or the lessons that experience is daily giving to parents, will for a long time yet do much in the way of making such cases fewer. We are living under the reign of the schoolmaster. The impulse to have children acquire learning that can never be made available for any purpose of life is so powerful that it may almost be regarded as morbid. And this is especially the case relative to girls, who are made to spend years in getting a smattering knowledge of subjects which, if they knew them well, would not enhance their loveliness or render them any happier; but which, as it is, befog their minds with a multiplicity of ideas no one of which they clearly comprehend. Do not misunderstand me. I am not underrating the advantages of learning. If a person wishes to study the differential calculus, not with a view of benefiting his fellow-man, but for the object of conducing to his own happiness, let him do so. He will be wiser and better, and, whether he intends it or not, his fellow-man will be benefited. He has a right to judge for himself, and to seek his own happiness in the way that seems best to him. But for children to be reduced to one common level, as they are in our schools almost without exception, and to have studies crowded upon them in advance of their brain-development, are crimes against Nature, which Nature in her blind way expiates by punishing the wrong person, but which those who know the right should promptly expose.

The brain of a child is larger in proportion to its body than is that of the adult. A fact which is somewhat astonishing to those not aware of it is, that the head of a boy or girl does not grow in size after the seventh year; so that the hat that is worn at that age can be worn just as well at thirty. In the mean time the rest of the body has more than doubled in magnitude. Not only is the brain larger, but it is more excitable and more impressionable in the child than in the adult. At the same time the structure is immature. What it possesses in size it lacks in organization; consequently it is not at its maximum for severe and long-continued exertion, and when subjected to a strain of this kind it is certain to suffer. We have, all of us, seen children become mentally fatigued from very slight causes, even when they have been at the same time greatly interested. How much more, therefore, must their brains be tired when they have been forced to concentrate their attention upon subjects, the importance of which they do not appreciate!

The disadvantages to the child of overtasking its muscular system are well understood, and wise laws have been enacted by most civilized people protecting children from the greed of those who would, if left to their own devices, work them to excess. But there are no laws for the protection of their brains from the attacks of ignorant parents and guardians, the insidious warfare of the compilers of school-books who write treatises on physiology in rhyme for infants, and the ever-ready schoolmaster, who, with the child, a victim of a pernicious system, must carry out the behests of those set over him.

Every person who has tried both knows that an hour of intense mental exertion fatigues the whole system more than does a corresponding amount of the most severe physical work. The reason for this is very evident. The brain not only furnishes the force for thought and the other elements of the mind, but it keeps in action all the other organs of the body. If, therefore, the mind takes more than its share of this force, the heart, the stomach, the lungs, the muscles, suffer, and the feeling of weariness is experienced.

It must be borne in mind, also, that the brains of children are continually engaged in acquiring a knowledge of the objects and circumstances by which they are surrounded. An adult, for instance, goes into a room, and the things it contains scarcely attract his attention. He has already learned them. But with the child it is very different. He looks at every object with inquiring eyes; if possible he takes them into his hands so that he can get fuller ideas of them, and asks a hundred questions in regard to their qualities, uses, etc. From the very earliest period after birth the infant is in pursuit of knowledge. His open eyes stare with astonishment at the things within their range, and in a little while his other senses are brought into requisition to assist in adding to his acquirements. An infant two months old will stretch out his hands toward objects held near him, and will incline his whole body with arms extended toward those that he has already learned are too far off for him to grasp. Perhaps, as Plato says, all these manifestations are due to the wonder with which the child's mind is full, but they lead to knowledge whatever may be the exciting cause, and they result directly from the action of the brain.

Undoubtedly the first faculties of the child's mind to be brought into action are the perceptions or senses; and for their exercise, certain organs, as the eye, the ear, the nose, the tongue, the skin, are provided. Through these organs the education of the infant takes place, beginning at birth, and even, as there is good evidence for believing, before birth. Were it not for these instruments, as they may be called, no single point of knowledge could be acquired, no idea formed. The brain, no matter how perfect its organization in other respects, might as well, so far as thought, feeling, and all relations with the external world are concerned, be a block of wood.

The intellect of the infant is immature, for the reason that the part of the brain which is concerned in the process of elaborating the higher qualities of the mind, is in a far more imperfect state of development than is that part which has direct relations with the organs of the special senses. The perceptions and the ideas that are elaborated from them give all the exercise to the inchoate brain that it requires for its full development. Through the perceptions the systematic education of the child should be almost exclusively conducted during the first ten or twelve years of life, and there should be no set lessons to worry his power of attention, to spur his understanding, or to tax his memory. He should be taught how to acquire knowledge by the use of his senses, and there are facts enough surrounding him on all sides to keep him as much engaged as is proper. His own reflections, started into activity, as they will be by his perceptions and by the questions he will ask, will do the rest. He will learn to read almost imperceptibly, of his own accord, with scarcely a word of instruction. If he does not begin to look at books till he is ten years old, he will, by the time a year has elapsed, read better than the child that has begun to learn his letters at three or four. He starts in the race with an unwearied and a better developed brain, and in the long run through life will win more prizes than his precocious competitor.

It is astonishing to find how greatly the perceptions of children are neglected by those who have them in charge. I have frequently been struck with the fact that even pupils who are considered to be well advanced do not know how to use, with even moderate ability, their sense-organs. I met not long ago with a boy of ten years who had mastered, to the satisfaction of his admiring parents, several branches of knowledge; and yet, when shown a picture in a child's book, told to look at it closely for a minute, and then to tell what he had seen, could name only a man, a horse, and a tree. His little sister, seven years old, who did not know how to read, and who was regarded by the father and mother as being somewhat stupid, saw, under like circumstances, a man, a horse, a tree, two little birds on the ground, a cat crawling through the bushes and about to spring on them, a house, a woman standing in the door, and a well at the side of the house. I had the satisfaction of telling the parents that at sixteen she would know a good deal more than would the boy at that age, provided she had an equal chance. Here is the opportunity for those who have charge of children during the first ten or twelve years of their lives. All Nature is before them: the woods, the fields, the sea, the heavens, animals of all kinds, men and women, the habitations of man, factories and the various objects made in them, and a thousand other things, afford the means for educating the child without a single book being brought into use. Even very young children can be taught to employ their eyes to some purpose by having attractive pictures submitted to them for observation. Such exercises would interest the mind, and at the same time develop it. The picture-books made nowadays are generally very admirable; but there might be pictures specially designed for the purpose of teaching and not merely for amusement.

One of the greatest mistakes made in our present system of educating children is, that they are given too many subjects to study at once. The power of dissociation—that is, of keeping one subject entirely clear of another subject—is not great in the minds of children. They therefore have a mass of confused ideas when they have got through with their daily tasks, which it is always difficult, and sometimes impossible, for them to separate one from the other. It is true that some children are, from the beginning, able to concentrate the attention first on one subject and then on another; but these are quite exceptional instances, and the brain is very likely to be strained in the effort. It is as though a person should spend six hours in looking alternately through a telescope and a microscope, giving a few minutes to each. It would certainly be found at the end of that time that the sight had been injured for the time being, at least, and if the practice should be continued there can be no doubt that permanent impairment of vision would be the result.

The effort to form and maintain clear and forcible ideas of several subjects at once is a difficult matter, even for adults. It has been found by experience that it is advantageous to reduce the number of branches of medical science which students are required to study simultaneously. Several of the better class of medical colleges in this country a few years ago cut down the list of from eight or ten to less than half the number, and extended the period of study from two sessions of four months each to three of from six to eight months. I speak from personal experience when I say that I am aware of the most lamentable results of the "cramming" process in medical students. I have been a teacher in medical schools for nearly twenty-five years. In the course of my examinations it has often happened that I have put a question in one branch of medicine to a candidate for graduation and have received an answer in an entirely different branch. How much better it would be for the future man or woman if the boy or girl, instead of being required to learn a dozen different subjects at once, as was the poor little victim of St. Vitus's dance to whom I referred in the beginning of my remarks, should have the number reduced to two, or at most three! Geography, for instance, might easily be sufficiently learned in three months if it were taught exclusively, and so of many other subjects. As for grammar, it should be banished from all schools, except perhaps from the senior year of a university course. No child ever learned to speak good English from studying grammar. It has driven many a poor little wretch into headaches and other nervous troubles. It is the most ingenious device for forcing an immature brain into early decrepitude that the cunning of man has yet devised. The only reason why it does not do more harm is, that not one in ten of the pupils that come out of our schools know anything about it.

So far as my experience goes (and my profession has brought me many opportunities for observation), there is too much cramming in all our schools, and too much learning by rote, without there being an understanding of the subjects studied. It appears to be the main object of some teachers to develop the memory at the expense of the other mental faculties. Now the memory is one of the lowest faculties of the mind. In fact, it is not a faculty, but simply the result of the registration of impressions. It is a property of certain parts of the brain-substance, and it often exists in its highest form in persons of low intelligence, in whom it is exerted automatically, as it were, and without reason. If the perceptions and the power of mental concentration be cultivated, the memory will take care of itself.

It is generally the case that those persons who possess good memories are deficient in the capacity for giving attention. Facts and circumstances make little impression upon us all as we grow older. Hence we find that the events which occurred in childhood, and which were registered then, are easily remembered, while those that happened only a few weeks ago, not having been sufficiently noticed at the time, made little impression on the registering apparatus of the brain, and are partly or wholly forgotten.

Persons with good memories are, as a rule, indifferent students; they trust to memory rather than to understanding, and hence rarely have clear and full ideas of the subjects studied. Of course there are persons with strong memories and great intelligence and powers of application, but they do not require schools. They are competent to take care of themselves, and they do. The text-books used in schools generally take too much for granted on the part of the student. Bald statements are made without sufficient explanation; the pupil learns them by heart, and is supposed to know all about them because he can recite them without missing a word. I recollect how it was with myself in the matter of geometry. I took the first premium at school for recitations in that branch of science. I used to go up to the blackboard, draw all my lines correctly, and then, without hesitating at a word, glibly make the required demonstration; and yet of the real nature of geometry I had no idea. I did not know the use of it, nor did I acquire the knowledge till, some years subsequently, I took up the matter for myself. How often it is the case in our schools that memory passes for knowledge, leading to the belief that the possessor has mastered a subject, when in fact scarcely an inkling of it is obtained! They make admirable recitations, but so does a parrot.

It may be said that, although at the time a subject is not understood by the child, the memorizing of the words in which the details of it are expressed helps him in after-life to comprehend it. This I am sure is erroneous. The exact language used is of no consequence; time is wasted in acquiring it—time that might be much more profitably employed in obtaining ideas. And very often it happens, from the inability of the compilers of school-books to write good English, that the words used are not such as best express the idea sought to be conveyed, and indeed are sometimes altogether wrong. Thus, for instance, in a recently published history of the United States "pyrites" is defined as "a yellowish mineral of no value, but from its likeness to gold sometimes mistaken for it." This is almost as bad as the definition of crab given by the French academicians as "a small red fish, which goes backward." As Cuvier remarked, this is correct, except in three respects—a crab is not red, it is not a fish, and it does not go backward. In the same book "knighthood" is defined as "a rank in nobility." Such errors as these, as I have ascertained by inquiring, are not corrected by the teachers.

The "cramming" process not only results in injuring the brain, but it tends to give only superficial ideas of many subjects instead of a thorough knowledge of a few. It is greatly to the detriment of society that it should contain, as it does, a large proportion of persons who have imbibed a superficial acquaintance with branches of learning that, in the ordinary courses of their lives, they are not likely to make use of. As remarked by General Fry, in his admirable address, a few days ago, before the Military Service Institution, they are often tempted to employ their acquirements in the perpetration of crimes requiring some, though perhaps very slight, scientific knowledge, and again in concealing the evidence of their unlawful acts. It is very certain that such crimes were never so common as at the present day, when almost every person has at least a smattering knowledge of physics, chemistry, and toxicology.

The men and women who have made the most of themselves are those who have begun to study hard after they have reached adult life, when the brain and nervous system have more nearly arrived at their fully developed stage. It is true that the world has seen many geniuses, who have taken their education into their own hands, regardless of schools and teachers; but mankind is not made up of geniuses. I doubt if there be a single one in any school in the city of New York, and therefore in a paper like this it is not necessary to take them into consideration.

These people who make their own way, unaided by wealth or influence, have never studied a dozen or more subjects at the village school, where at most they learned the "three R's"—reading, writing, and arithmetic—and where their physical forces were not deteriorated by want of bodily exercise. What they learned from the country schoolmaster they learned well, not because of any original superiority of their brains over the brains of the children of the present day, but because they did not go to school till they were well-grown children, and, further, for the reason that their minds were not tortured with a multiplicity of subjects to be learned, or goaded by the system of competition which prevails in almost all schools of the present day. Then, when they had arrived at that period of life at which their predilections were formed, they entered with ardor upon studies that they selected for themselves; for they knew exactly what they wanted, and governed themselves accordingly. They frequented reading-rooms and libraries, at such times as they could take from the labor necessary for their support, and they devoted their nights to the study of matters that it was necessary for them to understand. One hour of this kind of mental work, with a brain near its full development, and with the attention roused to its utmost power of exertion by the sense of necessity, the spur of ambition, the longing for success, is worth more than three times the amount with brains needing all their force for natural growth, and which are confused and painful from the alternate blandishments and lashings to which they have been subjected.

If a law were passed prohibiting the public schools teaching children under ten years of age from books, and restricting the education given therein to the elementary branches of English, I am sure that, as the ages of the pupils increased, healthy differentiations would take place. The principle of natural selection would come into action, and the result would be beneficial both to the individual and to the State. Something like this is now being attempted in a few of our colleges, and it appears to work well. It is not often the case that pupils will, of their own accord, cram themselves beyond their capacity, though cases now and then occur, through the operation of the factors of competition and an inordinately stimulated ambition, in which there is such a perversion of the natural tendencies that children eagerly overwork themselves at school. We should no more trust children with a superfluity of studies than we should place them at a table filled with toothsome edibles and tell them to eat as much as they wanted. In the one case there would be mental and in the other bodily indigestion. Montaigne speaks with no uncertain voice in regard to this matter.

"Too much learning," he says, "stifles the soul just as plants are stifled with too much moisture, and lamps by too much oil; for pedants plunder knowledge from books and carry it on the tip of their lips, just as birds carry seeds wherewith to feed their young. The care and expense that we received from our parents in our education go for nothing but to furnish our heads with knowledge, but give us nothing of judgment or virtue. We labor only to stuff the memory, but leave the conscience and the understanding empty and unfurnished."

"Mere bookish learning," he says again, "is both troublesome and ungraceful; and, though it may serve for some kind of ornament, there is yet no foundation for any superstructure to be built upon it."

Students of mature life study the things themselves, and not the descriptions of them. How much better it would be if "object-lessons" were more common in our schools! What idea of "network," for instance, could a child possibly obtain from Dr. Johnson's definition of it, "a reticulated structure, with interstices between the intersections"? Would he not know more about a net after having seen one than he would after having learned by rote such a definition? And would not, in fact, the words used by Dr. Johnson tend to unsettle all the knowledge of a net that observation had given him?

As one mode by which a reform in our systems of educating the young can be brought about, let there be more schools for children of a larger growth. I am satisfied, from observation, that the public night-schools of this city do more good, according to their opportunities, than do those that, through the day, from nine to three o'clock are crowded with young children, tiring their poor little brains over subjects that do not interest them, for they do not appreciate their value. A child ought to see some tangible result of his efforts to acquire knowledge, and this he can only do when he is taught facts that he understands and recognizes to be facts. In this kind of instruction the mental strain is reduced to a minimum, while the mental development is carried on in accordance with Nature's laws. At the first sign of fatigue the instruction should cease. As our schools are at present conducted, all the pupils are made to conform to one uniform standard of cast-iron rigidity. Weariness counts for nothing with the feeble, so long as the robust are not tired. The exhausted child can not, like the exhausted adult, stop of his own volition. He must go on. The jaded nervous system cries out in vain, his face may look as haggard as it can, yawn follows yawn, his head may droop, his eyes may close in the drowsiness of his languor; but the goad is applied, and he must rouse himself, for another lesson is to be recited. Is it strange that headache, and nervous prostration, and insomnia, and St. Vitus's dance, and epilepsy, and utter extinction of mind should frequently result from this forcing process? Is it not much better for the child that he should occasionally play truant, and go off to some vacant lot and engage in a game of ball?

I confess to a strong sympathy with the intelligent truant, who loves the fields and the shore better than he does the overcrowded, ill-ventilated, and brain-prodding school-room.

The differential education of the sexes is a subject that can not well be omitted from an address such as this purports to be, and it may well engage a little attention before I bring these remarks to a close.

And first a few words in regard to the comparative anatomy and physiology of the male and female brain.

The skull of the male of the human species is of greater capacity than that of the female, and it is a singular fact that the difference in favor of the male increases with civilization. Thus in savage nations as the Australians and the negroes of Africa, the skulls of men and women are much more alike in size than they are in Europeans. It would appear from this fact, either that women from some cause or other have not availed themselves of the advantages of civilization as factors in brain-development to the same extent as man has; or that among savages there is not that dissimilarity in mental work that is found among civilized nations, and that hence there is not the same necessity for a difference in brain-development. For it naturally follows that, in the normal skull, there is a correspondence between its size and that of the organ contained within it.

Many observations have shown that the average male brain weighs a little over forty-nine ounces, while the average female brain is a little over forty-four ounces, or about five ounces less. The proportion existing between the two is therefore as 100 : 90.

This apparently makes a good showing for man, but when we look at the matter in another, and possibly a more correct light, the advantage is rather the other way; for, relatively to the weight of the body in the two sexes, the difference, what there is, is in favor of woman. The body of the female is shorter and weighs less than that of the male. Thus, in man the weight of the brain to that of the body has been found to be an average of 1 : 36·50, while in woman it is as 1 : 36·46, a difference of ·04 in her favor. I have said that possibly this may be a more correct way of determining the size of the brain than by absolute measurements without regard to the size of the body. The doubt arises from the fact that we do not know that very thin persons, in whom of course, other things being equal, the brain would be relatively larger, are more remarkable for mental vigor than are very stout ones, in whom the relative size of the brain would be less. Such being the case, it is difficult to believe that the proportionate size of the brain to that of the body has any important influence as a factor in the production of mind. It is the absolute rather than the relative amount of gray matter that is to be considered in determining the brain-power. It must, however, be borne in mind that the quantity of gray matter can not always be positively affirmed from a determination of the size of the brain, though in *general* it can. A person, for instance, may have a large head and a large brain and the layer of cortical substance be very thin; and another person with a smaller brain may have the cortex so thick as to more than compensate for its small superficies. Still, these are exceptional cases; as a rule, the larger the brain the greater the mental power of the individual.

Another difference between the brain of man and that of woman is found in the conformation of the organ. In man the frontal region is more developed than it is in woman. There is a certain fissure called the fissure of Rolando, which divides the brain into two unequal parts. Now, if we take the entire length of the brain as = 100, there will be found in woman 31·3 parts in front of the upper end of this fissure, while in man there will be 43·9 parts.

Again the specific gravity of the male brain, both of the white and the gray substance, is greater in man than it is in woman.

Bearing in view these differences, it is impossible to avoid the conclusion that there must also be some points of dissimilarity in the minds of the two sexes. Not necessarily that one is superior to the other, but that they are different. This is an assertion that will probably not be questioned by any one who will take the trouble to give a little reflection to the matter. We see the diversities every day—diversities of perception, of emotion, of intellect, of will. In some respects the mind of man excels; in others, that of woman is superior. It would be a bad state of things for mankind if the mind in the two primary divisions of the human race were the same. In barbarous nations, as we have seen, the difference in size is less than it is with civilized people, and as one consequence of this fact there is not so great a difference in the mental development. The work of a woman is with them almost the same as that of a man. Her mode of life, her dress are not essentially different except in so far as they must be different on account of her sex. But with civilized nations there is variety in modes of thought, in likes and dislikes, and in other mental characteristics; in occupation, in manner, in clothes, even in food, so that the differentiation between the sexes is far more distinctly marked than it is with nations low in the scale of progress. Who can doubt that this is the direct result of differences not only in the brain but in other parts of the nervous system?

It appears to me, therefore, that while the education of a woman should be just as thorough as that of a man, it ought not to be the same. The two sexes move through paths that approach parallelism at some points of their course; but they can never travel exactly the same road till they have nervous systems presenting exactly the same anatomical configuration and situation.*

Such being the case, it is the height of absurdity to attempt, what is so often attempted at the present day, the education of girls according to the same method as that pursued for boys, and giving them

* The immediately preceding paragraphs on the differences between the brains of man and woman are taken almost *verbatim* from my address entitled "The Relations between the Mind and the Nervous System," delivered at the Lehigh University on "Founder's Day," October 9, 1884, and published in "The Popular Science Monthly" for November, 1884.

almost identical studies. The effort to cram mathematics, for instance, into the female mind almost always results in failure. It is true that there have been a few women distinguished as mathematicians, but they have been so from natural predilection, and are exceptions to the general rule. I have seen many cases of girls whose nervous systems have been wofully disturbed in the endeavor to master algebra, geometry, spherical trigonometry, and other mathematical branches of knowledge that could not by any possibility be of use to them. And how many women, notwithstanding all the efforts made, have even a smattering of these subjects? Their minds revolt at the idea. Nevertheless, not only are the higher branches of mathematics kept in the curricula of many of our schools for girls, but even civil-engineering and other applied mathematical studies are pursued. I do not think that absurdity can go much further than this. They might as well include navigation; and as a woman was a short time ago licensed as captain of a Mississippi steamboat, I shall expect to hear the fact used as an argument in favor of this extension of the educational facilities for girls.

Doubtless in time the evils that I have endeavored to point out this evening will be done away with. The craze for giving every child a smattering of every branch of knowledge will disappear, but it will probably not be in our day. All the world professes to be opposed to cramming, but the system nevertheless goes on, not only unchecked, but to a greater extent year after year. The days when children really knew something well will doubtless come back, and the future teachers in medical schools will not be disgusted as I have been with the badly trained minds of many medical students who sit with gaping mouths scarcely comprehending a word of a lecture, though put in the simplest diction of the language. Pupils will then be taught to think, and not as at present to absorb without understanding.

One word more, and I have done. For the teachers, men and women, in our public and private schools, I have the most profound respect. They simply follow the system that is laid down for them, and they do it, I verily believe, with a consciousness that it is faulty in the extreme. They are, however, powerless to effect a change. At the least suggestion toward a deviation from the beaten track, school committees and commissioners of education, and, above all, blind and ignorant parents, would insist upon "the pound of flesh," "the worth of their money," and the cramming process would have to go on. To these latter our efforts at reform must be addressed. A body such as is the Nineteenth Century Club can do much toward the spread of proper ideas in regard to this important matter, and, if it sees things as I have endeavored to set them forth to-night, a mighty impulse will be brought to bear in support of a righteous cause.

THE HISTORY OF A DELUSION.

By M. G. VALBERT.

IN the year of grace 1838, MM. d'Ennery and Anicet Bourgeois presented at the Théâtre l'Ambigu a drama entitled "Gaspard Hauser." In the same year "The Poor Idiot of the Cellar of Elberg" was played at le Gaîté, the Poor Idiot being also Gaspard or Caspar Hauser. Although he had been dead five years, impressible people still continued to be interested in the puzzle of his identity. The world had been full of his name and of the fame of his mysterious adventures, and he had been surnamed the child of Europe. To-day we French have almost forgotten him; but the Germans have not ceased to be occupied with him and to search for the solution of an enigma which has caused floods of ink to be shed, and has been the occasion of violent and abusive polemics.

In 1872, Dr. Julius Meyer published "Authentic Communications respecting Caspar Hauser." He provoked a lively response from professor Daumer, who published a new and learned study on the child of Europe, "upon his innocence, his sufferings, and his origin." He declared in it that "every good German was bound to believe in the princely origin of Caspar Hauser, and that one could not doubt it without making proof of rationalistic and satanic incredulity." In 1882 an anonymous pamphlet was published at Ratisbon which was intended to demonstrate again to the world that Caspar was the son of the Grand-duchess Stephanie, and the legitimate heir of the grand-duchy of Baden. A few years previously, the Emperor William had induced the grand-duke, his son-in-law, to shut the mouths of calumniators by publishing some documents which were preserved in the archives at Carlsruhe. The anonymous author, however, pretended to have derived his materials from important papers left by a person in a very high position, who was no other than the Grand-duchess Stephanie herself. Strong in such testimony, he had undertaken to throw light upon a long-kept secret and into the mysteries of a dark and iniquitous intrigue.

The anonymous author knew how to write and how to tell a story, and we read his book with as much interest as caution. The court of Ratisbon, trying the case, adjudicated concerning the author and his story that the famous pamphlet had been compiled from previous documents which were destitute of all authority, and that it swarmed with inexact, false, and, more than once, wild allegations. The publisher, who appealed from the judgment, was condemned to pay costs, and forced to withdraw the book from the market. A full and serious history of the pretended idiot has just been published by Herr Antonius von der Linde, in two rather overlarge octavo vulumes. Although it was hardly worth while to give so much labor and matter to the proving Caspar Hauser to be an impostor, Herr von der Linde's volumes* will interest those who would like to know how legends are started, how they spread, and how they impose themselves on gossips, to whom the wonderful is the more charming as it is less probable.

On the 26th of May, 1828, there appeared in Nuremberg a stout, short boy, sixteen or eighteen years old, of rustic appearance, having light-chestnut hair, gray eyes, and a downy beginning of beard, and wearing a large felt hat, a jacket of dark-gray cloth, with breeches of the same, blue stockings, and hob-nailed half-boots. He had a letter without signature, addressed to Herr Friedrich von Wessenig, major in the sixth light cavalry, which read: "I send you a youth who wishes to serve, like his father, in the light-horse. He was put into my charge by his mother on the 7th of October, 1812. I am a poor day's worker, with a family to take care of. I have brought the boy up in the Christian religion, and have never let him go away from my house, so that not a soul in the world knows where he has lived till now. Do not question him on this subject, for he can not tell you anything. To keep him more in the dark, I brought him as far as Neumark in the night. He has not a sou. If you don't want to keep him, kill him, or hang him up by the chimney." This letter inclosed another one, which was regarded as of sixteen years' earlier date, on paper of similar character, and apparently in the same hand. It read in substance: "The child has been baptized, and his name is Caspar. When he is seventeen years old, send him to Nuremberg, to the light cavalry regiment. He was born on the 30th of April, 1812. I am a poor girl and can not support him, and his father is dead."

Herr von Wessenig questioned the youth, but he could not tell who he was or where he had come from. Such prodigious ignorance appeared suspicious to the major, and he sent the letters to the police commissioner, asking his advice about them. The police at first regarded Caspar as a vagabond, and he was locked up. Three points seemed to be established: that he was born on the 30th of April, 1812; that he was the illegitimate son of a poor girl and a light-cavalry man; and, as his dialect indicated, that he was a native of some part of Bavaria, near the borders of Bohemia. More than this, he had something to conceal: he had probably committed some offense, which he did not care about acknowledging to the police, and was trying to cover up his tracks. When he saw that, instead of his being enrolled in the cavalry, they were taking him to prison, he made himself appear still more simple-minded and silly than before. If they had taken a sensible course in the matter, Herr von der Linde justly observes, they could soon have cleared up the mystery; "but they did not think of looking upon the ground, and gazed into the clouds."

* Kaspar Hauser, eine neuegeschichtliche Legende, von Antonius von der Linde. Wiesbaden, 1887.

The report soon spread through Nuremberg that the police had in prison a strange being, of queer appearance, who only answered, "I don't know," to every question that was asked him. The innocent became the object of a lively curiosity, and, in a short time, of tender compassion. The public came to see him, they examined him from head to foot, and tried to make him talk. Nuremberg had at the time as its head burgomaster a very respectable, good-hearted man, of a simplicity that was easily taken in. He put himself in relations with Caspar Hauser and obtained from the mute his story of some things which he had, he said, been peremptorily forbidden to reveal. From his most tender infancy he had lived shut up in a close cellar, having two little windows that let in only a very uncertain and dim light. He had lived there for long years, dragging himself on the hard ground, without ever getting a sight of the sky, the sun, or the moon, or hearing a human voice, the song of a bird, the cry of an animal, or the sound of a footstep. His ration of food was brought to him while he was asleep; when he awoke he would perceive near his straw mat a piece of bread and a mug of water. For companions in his captivity he had nothing but a few wooden playthings.

One morning he had seen his door open, and a middling-sized man, rather poorly dressed, told him that he should know his father some day, and that he was destined to be a cavalry man as he had been, but must first learn to read and write and cipher. The unknown man came back every five days afterward to teach him the alphabet. At last, one night the unknown took him on his back, carried him out of the cellar, dressed him, and taught him how to walk. They traveled together for several days and nights, and then "the black man" gave Caspar the two letters, with his final instructions, and disappeared like a dream.

The burgomaster took the pains to tell this wonderful history to all Germany, and all Germany was moved by it. But a few brave minds refused to put any faith in it. They argued that Caspar Hauser hardly looked like a young man who had been sequestered for many years in a close, dark cellar, and that he had neither the color nor the face nor the walk of such a person. He looked well, and had a good figure and the freedom of all his limbs. Was it probable, too, that such a prisoner, who had never used his legs, had performed a march of several days and nights without the soles of his feet bearing the mark of a blister or an abrasion?

The striking contradictions between his new ways of speaking and acting, and his attitude in the first days, should also be remarked. He had come to Nuremberg with too tight boots, but they did not prevent his going and coming with ease. Other, larger ones, were given him. On putting them on, he pretended to be as awkward about them as a monkey that has to wear boots for the first time; and to be not able to stand up or to walk. When he was presented to Herr von Wessenig he played before the major the part of a great lubber of short wits, but still more of a sly-boots than of a fool. After he had determined to tell the story about the cellar, he affected ignorance and wonder at every thing. The sun and moon were to him new acquaintances, with which it was hard to make himself familiar, and the light troubled him. He seemed to believe that flowers and leaves and trees were made by the hands of men, and would say in his dialect: "How much time that must have taken them! Why be at so much trouble about it?" He spoke of himself in the third person, and talked to the bread that he was eating. The first time he saw a candle lighted, he asked them to give him the flame, so that he could put it on his wooden horse, which he pretended bit him sometimes. All of these things appeared suspicious to well-informed and reflecting persons, but their doubts were regarded as impious by believers. It had been decided that the wonderful story was true, and all Nuremberg believed in it. There are moral epidemics and times when nothing is less common than common sense.

Caspar Hauser, having become the adopted son of the whole city, did not stay long in prison. He was first admitted into the family of the jailer, Hiltel; then he was entertained by Professor Daumer, who regarded him as a prodigy; and then in the house of municipal Councilor Biberbach. His fame went everywhere. Members of courts and cabinets occupied themselves with his adventures. Conjecture was exhausted in the effort to discover his parents, and to pierce the mystery of his long sequestration. He was made to relate his dreams, in the hope that some light might be extracted from them. Grand personages went out of their way to visit Nuremberg in order to see and question him. Count Stanhope conceived so lively an affection for him that he wanted to take upon himself the future care of him. Masters were introduced to him who tried to take the rudeness out of him and polish him, and even to teach him Latin. Indolent, and stupid as a marmot, he complained that they were drying up his mind with the study of such trash. The only marked taste he showed was for horseback-riding, in which he excelled. He exhibited but little recognition of the cares and attentions which they put upon him. He had a low and gross mind and a hard, ungrateful heart, while his insupportable vanity, indiscreetly pampered, grew from day to day. Women doted upon him, loaded him with favors and presents, and said sweet things to him.

An incident which made considerable stir completed the demonstration to persons of a willing disposition on the subject that Caspar Hauser was a young man of high lineage, and that his unknown persecutors had a large interest in bringing about his disappearance. On the 17th of October, 1829, while he was lodging with Professor Daumer, he was surprised in a closet by a black man (*un homme noir*), who struck him in the forehead with a sharp instrument, and went away, saying, "You shall die before you go away from Nuremberg!" Caspar recognized in this man the same person who had taken him out of the cellar, and who doubtless wished to punish him for having broken silence and told his story to the gossiping burgomaster. Nobody but Caspar had seen this black man, who seemed to have vanished in the air like smoke, after having struck the youth. Search was instituted for him, and inquisitions were made to recover traces of him; but no news was had of him. From that day, however, due pains were taken to protect the child of Europe against the assassins who were watching for him; and he never went out without an escort of two guards.

These precautions were relaxed little by little, and some time after this Caspar left Nuremberg and went to reside at Anspach, under the care and at the expense of Count Stanhope. He became a boarding-pupil of schoolmaster Meyer, whom he caused much annoyance. On the 14th of December, 1833, as he was walking alone in the Public Garden, he was again accosted by a black man, who presented him with a purse; and he was at the same time struck on his left side with a dagger. The purse contained a note written in a back hand, and reading: "Hauser will be able to describe my appearance to you, and tell you where I came from. To save him the trouble, I will tell you myself: I came from the frontier of Bavaria. I will tell you my name, too: M. L. O." The second assassin was as indiscoverable as the other one. Unfortunately, the wound was graver than was thought at first, and Caspar died on the 17th of December, having exclaimed, "O God, God! must I die thus in shame and disgrace?"

There was at the time in Berlin a counselor of police named Merker, a very methodical, exact, logical man, whose sagacity it was hard to outwit. Struck with the accumulation of improbabilities in the stories of Caspar Hauser, he drew the conclusion from them that "either we must believe in miracles, or Caspar is an impostor." "It will be said some day, in some course of universal history," he wrote, "that a young man appeared one evening in a German city as if he had fallen from a star; but the sky was not his country; he had come out of an underground dungeon, and saw daylight now for the first time. A mysterious unknown had brought him out of his hole, and this unknown was at the same time his jailer, his master, his tutor, his deliverer, and the man commissioned to assassinate him. The police of the city of Nuremberg found something queer in this story, and regarded the miraculous child as a very ordinary vagabond. But the world soon became occupied with him. They wrote books and a great many articles in the journals about him. The extraordinary being became the object of profound scientific researches. His saliva, his urine, his evacuations were learnedly analyzed; his ways of acting, even his sneezings, were studied and commented upon as if they were affairs of state. If any one ventured to express a doubt, he was dishonored and despised; and a miraculous event was learnedly explained by other events still more miraculous."

A circumstance that confirmed Merker's suspicions and skepticism was the fact that everybody who had anything to do with Caspar Hauser surprised him, at some time or another, in some flagrant lie. Madame Biberbach wrote, on the 19th of February, 1832: "How many bitter hours has this child made us pass! How many griefs and vexations has he caused us by his absolute want of truthfulness! When we catch him in the act, he pretends to repent, and promises to amend, and we begin to love him again; but the demon of falsehood has so fully taken possession of him that he is always falling back into his sin, and going deeper and deeper into his vice. From the time when he saw himself detected his heart was estranged from us." Count Stanhope, who had loved him as a father, began to grow cool toward him and to mistrust him. After having dreamed of the most brilliant career for him, his illusions dispelled, he had no better thought for him than to find him employment with some large stable. Merker inferred from these facts that the miraculous child, seeing his high hopes failing and uneasy about his future, had felt the necessity of bringing back his benefactors, and of fortifying their wavering faith by a new comedy; that he had invoked the phantom of the black man, in which Count Stanhope did not more than half believe, for the second time; that the assassin of Caspar Hauser was Caspar himself; that he had struck himself with the dagger, but had struck too hard; that he was the victim of his own maladroitness, and that his death was an involuntary suicide.

The idle populace reasoned very differently from the suspicious and sagacious police counselor. They believed more than ever in the black man, and in the noble origin of Caspar Hauser. They had made him by turns the son of a village curate, or of a canon, or bishop, or baron, or count, or Hungarian magnate. They now held it for certain that he was born in a palace, that his mother had reigned somewhere, and that faithless collaterals had seized the heritage of the child of Europe. Suspicion shortly fastened upon the house of Baden, and the bell was so well fixed to it that it tinkles even yet at the slightest breath of gossip that blows over Carlsruhe.

The Margrave Charles Frederick, who became grand-duke in 1806, was married twice. After the death of the Princess Caroline, of Hesse-Darmstadt, he concluded a morganatic union with Madame Hochberg, countess of the empire, who was born Geyer von Geyerberg. His successor was his grandson Charles, who married Stephanie Louise Adrienne de Beauharnais, a lady who had been brought up by the Emperor Napoleon, with the rank of a princess of France. She had five children, of whom two sons died, one a few days, the other a few months, after birth. The former, born on the 29th of September, 1812, died on the 16th of October of the same year; the second lived from the 1st of May, 1816, to the 8th of May, 1817. By the death of these two princes the succession passed to Louis I, uncle of the Grand-duke Charles, and after him to the descendants of the second marriage—to the morganatic line which now reigns in Carlsruhe. Those were found who could imagine and affirm that the prince born in 1812 was not dead, but that persons interested in his disappearance had caused him to be abducted, and had substituted for him another child who had shortly died, and that the stout boy who, on the 26th of May, 1828, presented himself, letter in hand, before Major Friedrich von Wessenig, was the real grand-ducal heir of Baden, who had been shut up for sixteen years.

This legend, revamped from the history of Cyrus, Romulus, and other great heroes, was hard to digest. Substitutions of children are attended by difficulties, especially when the child in question is a royal or nearly royal scion, an heir that has been ardently expected and impatiently waited for, and whose features have been fondly looked upon. On the 4th of October, 1812, the grandmother of the little prince, the Margravine Amelia of Baden wrote in French to her daughter, the Empress Elizabeth of Russia: "The wife of Charles was brought to bed on the 29th of September, with a son of enormous size in proportion to his mother's; it cost much trouble and suffering, too, to get him into the world. The event has caused much joy here." The grandmother examined the child closely, for on the 11th of October she wrote again to her daughter: "Everything is in joy here over the birth of an heir; what gives me the most pleasure about it is, that I find in him a resemblance to his father when he was a baby." But this rejoicing was of short duration. On the 18th of October, at eleven o'clock in the morning, the margravine took up the pen again, "to announce the death of the poor little one. . . . He only lived for seventeen days, with a vigor and healthfulness which made us hope for his preservation; but he was all at once seized with suffocation and convulsions in the head. . . . Charles is very much affected by it; I never saw him so much afflicted. I am grieved, because the child was so like the house of Baden. I was obliged to announce it yesterday morning to his mother, who was not anticipating anything of the kind. No one else would take it upon himself." She added, on the 25th of October, "The death of that child, who interested me because of the resemblance I found in him to the house of Baden, and whom I saw expire, . . . and the extreme grief of Charles—all that has overthrown me."

The grandmother saw the child born and saw him die; the father was there, too, and the nurse. The corpse was examined and opened in the presence of the state minister, Berckheim, and nine doctors. No one suspected substitution. Shall we believe that everybody was in the plot, including even the grandmother? No one has ventured to maintain this. It was once pretended that the man in the iron mask was the Count of Vermandois, a natural son of Louis XIV, who died, to the knowledge of the public, in the army, of small-pox, in 1683, and that they buried a stake to personate him, over which Louis XIV had a solemn service performed. It is easier to believe in this stake than to contemn a grandmother.

An improbable story will not make its way in the world unless it is patronized by some grand personage, who has an interest in accrediting it. No one contributed more to propagate the legend of Caspar Hauser than King Louis I of Bavaria, who bore little good-will to his neighbors in the west. His father, Maximilian Joseph, had promised himself to annex the Badenese palatinate to his states, and had concluded for that purpose a secret treaty with Austria in 1815. Men always dislike those whom they have not succeeded in despoiling. King Louis would have been very ready to discredit the descendants of the second marriage, who had mounted the throne in 1830, in the person of the Grand-duke Leopold I. The occasion seemed a good one for him to question the validity of their rights, and to insinuate to Europe that they had come to power through an abominable conspiracy, and that the legitimate heir was the stout boy whom he had harbored in his good city of Nuremberg. To please him, it was necessary to swallow the story with the eyes shut and the mouth wide open. Skeptics and cavilers evidently disobliged him.

Whether by compliance or for love of the marvelous, some persons in high circles were inclined to believe in Caspar. The painter Greil painted his portrait in pastel; he represented him as he saw him—that is, as an unprepossessing rustic of low physiognomy. The portrait was engraved, and the engraver transformed the rustic into a Prince Charming. The Princess Royal of Prussia, who was only acquainted with the engraving, wrote, in 1832, to Queen Caroline of Bavaria, sister of the Grand-duke Charles: "The portrait of this young man has vividly interested me. . . . I do not know whether it may not be the effect of my smitten imagination, but it seems that I find some resemblance between Hauser's features and those of your poor brother. . . . This face troubles me like a specter." But it was, above all, important to persuade the mother, the Grand-duchess Stephanie, and win her over to the good cause. Suffering greatly from the effects of a severe labor, she had seen little of her child; she had not witnessed his death; and it is very tempting to a mother to believe that her son is not dead. Caspar Hauser was frequently spoken of to her, and she was persuaded to have him brought to her, in the hope that her heart might tell her something. She shook her head, and continued incredulous. The celebrated jurist, Mittermaier, Professor of Law at Heidelberg, had a conversation with her on the subject. She declared to him that the abduction of her son and the substitution of another child was "a pure impossibility." "My mother," wrote the Duchess of Hamilton, "never believed a word of that story. That King Louis tried to persuade her to it is another matter. As to myself, I always answered that I held to the judgment of my mother, who has often said, like the old margravine, 'It is impossible.'"

But King Louis had on his side all the malcontents of the grand-duchy. Every gaming-master who complained of a denial of justice, every solicitor who had been refused, avenged his injury by saying, "Caspar Hauser became inconvenient to you, and you had him assassinated." The name of the mysterious personage who was supposed to have conducted the affair was boldly given, and Count Stanhope was accused of having been a go-between in the crime. The field was beaten for proofs of the accusations. Time and again some sharp-witted man in want of money would send word to the court of Carlsruhe that he was the possessor of secret papers in which the tragic adventure was related from point to point. He would ask for a large sum, and they would give nothing, and then he would publish his papers. Persons of keen scent and reading could recognize in his little work whole chapters from old *factums*, which had fallen into oblivion, and scenes extracted from a romance by Seybold, which was no longer read. Such, according to Herr von der Linde, was the history of the famous pamphlet of 1882, on which the tribunal of Ratisbon executed justice.

Merker reduced the question to these terms : We know nothing of Caspar Hauser except what it has pleased himself to tell us, and no one ever passed a week with him without surprising him more than once in a lie. What credit does a story deserve that is founded on the testimony of a downright liar ? But believers would object : Is it possible to suppose that a young man of an uncultivated and very narrow mind should have a genius for invention, and that he could maintain his imposture to the end without betraying himself or departing from his assumed part ? To this the doubters replied : that the public had kindly taken it in hand to facilitate his task for him, and open the way for him, which he had not even had to take the trouble to mark out. Some one has said that in France the first day is for infatuation, the second for criticism, and the third for indifference. The infatuation of the people of Nuremberg seems to have been more enduring than usual ; for the days of criticism and indifference never came for Caspar Hauser.

There are two kinds of cunning. One, which sometimes has genius in it, composes in advance a grand plan, conforms all its conduct to it, and prepares afar off, for its adversaries, traps which shall be sprung suddenly and surely. That is the cunning of Ulysses and the politicians. Caspar Hauser had nothing but the passive cunning of the chameleon, which changes color to agree with the objects around it. He accommodated himself to circumstances ; he lent himself with unlimited compliance to the desires and prejudices of his benefactors, and he worked upon their prepossessions and their open credulity.

Schoolmaster Meyer represented him as a man of robust body, ready with his hands, and of a more pliant mind than was generally thought, divining quickly enough with whom he was dealing, and governing his face and language accordingly. He came to Nuremberg without any other intention than to become a light cavalry man. He found people disposed to believe that he was a hero of romance and the victim of a dark conspiracy. He entered into their idea, and invented the childish story of the dungeon. People regarded him as simple-minded, and spoke freely before him. He took advantage of all that he heard, and was what they wanted him to be. The relative facility with which he played his part may be explained still more easily if we suppose, with Merker, that he had escaped from a traveling circus, where he had gained some knowledge of the art of riding horseback, and had learned to compose his face for the diversion of the idlers in the interludes. It is said that in the last months of his life he had conceived a project of making the tour of Europe, going from city to city, and making a show of himself. Such a way of getting a living suited him much better than the employment which Count Stanhope proposed. The natural man appeared again, and prevailed over the studied part.

The honest people who allowed themselves to be taken in by the story of the dungeon were never willing to give it up. To them it was as the last word of the gospel. It is hard to recant, and acknowledge that one has been duped. We have seen in Paris a mathematician of eminent merit holding as authentic letters in which Pascal taught attraction previous to Newton, and continuing to believe in those letters when no one else believed in them. We have seen in Prussia an illustrious Egyptologist recommending to the Academy of Sciences, as a work of incalculable value, a Greek manuscript fabricated by a forger, in which he found confirmation of some of his boldest conjectures; and it cost much trouble to make him acknowledge his error. The eminent criminalist, Anselm Feuerbach, who joined to a warm spirit and vivid imagination a taste for subtile ratiocinations and the art of deciphering the secrets of hearts, could not decipher Caspar Hauser. From the first day he regarded him as a miracle, and, having said it once, it was of no use to try to make him unsay it. "This dear foundling," he wrote to a friend in 1830, "has been for years the principal object of my studies, researches, and cares. An inhabitant of Saturn, falling during the night into the imperial city of Nuremberg, would not be enveloped in more mystery." He finally decided that Caspar Hauser was a Badenese prince, and till his death he was, with King Louis, the most zealous champion of the legend.

On the other side, physiologists and moralists, convinced that a young man who had passed sixteen years in the solitude of a dungeon might furnish valuable lessons respecting the primordial laws of human nature, studied him with devoted attention. Some thought that they could discover in him all the signs of the "animal man," and noted them down carefully. Others, persuaded, with Rousseau, that we are born good and pure, and that it is society that perverts us, went into ecstasies "before the miraculous innocence of this paradisiacal youth, the image of Adam before the fall." A homœopathic physician, Dr. Preu, discovered that infinitesimal dilutions had prodigious effects on this primitive being. He only had to open his medicine-case or uncork one of his vials to make the compliant Caspar fall into a swoon; and Hahnemann, hearing of the phenomenon, declared that the child of Europe was the living demonstration of homœopathy and the confusion of its enemies. The same Dr. Preu, laying it down as an axiom that "in a man who had passed his youth in a cellar the telluric principle ought to prevail over the solar principle," employed days and weeks in studying the action of metals and minerals on the nervous system of Caspar. He declared that jasper chilled his arm to the elbow, and chalcedony to the shoulder. Caspar lent himself obligingly to these varied experiments. He was told: "You should feel this; you should feel that." His answer would be, "I feel it." And Dr. Preu carefully registered his observations and analyses, as documents worthy of passing down to the most distant posterity. If the impostor had been unmasked, homœopathists, moralists, philosophers, theologians, and jurists would have been covered with ineffaceable ridicule. When they kept guard over the legend, it was to protect their self-respect against scoffers.

Herr von der Linde has more than proved that Caspar Hauser was not a grand-duke. It appears further from his book that of all the adventurers who have at any time imposed themselves on the attention of the world and forced it to hear their name; of all fraudulent heroes; of all intruders upon fame, Caspar was the least interesting and the nakedest of prestige and charm and grace. The greatest mark of wisdom that he gave was to die at twenty years of age.—*Translated for the Popular Science Monthly from the Revue des Deux Mondes.*

ASTRONOMY WITH AN OPERA-GLASS.

THE STARS OF SPRING.

By GARRETT P. SERVISS.

THERE was never a time when the heavens were studied by so many amateur astronomers as at present. In every civilized country many excellent telescopes are owned and used, often to very good purpose, by persons who are not practical astronomers, but who wish to see for themselves the marvels of the sky, and who occasionally stumble upon something that is new even to professional star-gazers. Yet, notwithstanding this activity in the cultivation of astronomical studies, it is probably safe to assert that hardly one person in a hundred knows the chief stars by name, or can even recognize the principal constellations, much less distinguish the planets from the fixed stars. And of course they know nothing of the intellectual pleasure that accompanies a knowledge of the stars. Modern astronomy is so rapidly and wonderfully linking the earth and the sun together, with all the orbs of space, in the bonds of close physical relationship, that a person of education and general intelligence can offer no valid excuse for not knowing where to look for Sirius or Aldebaran, or the Orion nebula, or the planet Jupiter. As Australia and New Zealand and the islands of the sea are made a part of the civilized world through the expanding influence of commerce and cultivation, so the suns and planets around us are, in a certain sense, falling under the dominion of the restless and resistless mind of man. We have come to possess vested intellectual interests in Mars and Saturn, and in the sun and all his multitude of fellows, which nobody can afford to ignore.

Perhaps one reason why the average educated man or woman knows so little of the starry heavens is because it is popularly supposed that only the most powerful telescopes and costly instruments of the observatory are capable of dealing with them. No greater mistake could be made. It does not require an optical instrument of any kind, nor much labor, as compared with that expended in the acquirement of some polished accomplishments regarded as indispensable, to give one an acquaintance with the stars and planets which will be not only pleasurable but useful. And with the aid of an opera-glass most interesting, gratifying, and, in some instances, scientifically valuable observations may be made in the heavens. I have more than once heard persons who knew nothing about the stars, and probably cared less, utter exclamations of surprise and delight when persuaded to look at certain parts of the sky with a good glass, and thereafter manifest an interest in astronomy of which they would formerly have believed themselves incapable.

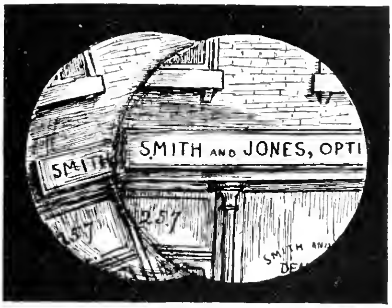
Being convinced that whoever will survey the heavens with a good opera-glass will feel repaid many fold for his time and labor, the present writer has undertaken to point out some of the objects most worthy of attention, and some of the means of making acquaintance with the stars.

First, a word about the instrument to be used. Galileo made his famous discoveries with what was, in principle of construction, simply an opera-glass. This form of telescope was afterward abandoned because very high magnifying powers could not be employed with it, and the field of view was restricted. But, on account of the brilliant illumination of objects looked at, and its convenience of form, the opera-glass is still a valuable and, in some respects, unrivaled instrument of observation.

In choosing an opera-glass, see first that the object-glasses are achromatic, although this caution is hardly necessary, for all modern opera-glasses are made with achromatic objectives. But there are great differences in the quality of the work. If a glass shows a colored fringe around a bright object reject it. Let the diameter of the object-glasses, which are the large lenses in the end farthest from the eye, be not less than an inch and a half. The magnifying power should be at least three diameters. A familiar way of estimating the magnifying power is by looking at a brick wall through one barrel of the opera-glass with one eye, while the other eye sees the wall without the intervention of the glass. Then notice how many bricks seen by the naked eye are required to equal in thickness one brick seen through the glass. That number represents the magnifying power.

The instrument used by the writer in making most of the observations for this sketch has object-glasses 1·6 inch in diameter, and a magnifying power of about three and one half times.

See that the fields of view given by the two barrels of the opera-glass coincide, or blend perfectly together. If one appears to partially overlap the other when looking at a distant object, the effect is very annoying. This fault arises from the barrels of the opera-glass being placed too far apart, so that their optical centers do not coincide with the centers of the observer's eyes.



Occasionally, on account of faulty centering of the lenses, a double image is given of objects looked at, as illustrated in the accompanying cut. In such a case the glass is worthless; but if the effect is simply the addition of a small, crescent-shaped extension on one side of the field of view without any reduplication, the fault may be overlooked, though it is far better to select a glass that gives a perfectly round field. Some glasses have an arrangement for adjusting the distance between the barrels to suit the eyes of different persons, and it would be well if all were made adjustable in the same way.

Don't buy a cheap glass, but don't waste your money on fancy mountings. What the Rev. T. W. Webb says of telescopes is equally true of opera-glasses: "Inferior articles may be showily got up, and the outside must go for nothing." There are a few makers, whose names stamped upon the instrument, may generally be regarded as a guarantee of excellence. But the best test is that of actual performance. I have a field-glass which I found in a pawn-shop, that has no maker's name upon it, but is quite capable of bearing critical comparison with the work of the best advertised opticians. And this leads me to say that, by the exercise of good judgment, one may occasionally purchase superior glasses at very reasonable prices in the pawn-shops. Ask to be shown the old and well-tried articles; you may find among them a second-hand glass of fine optical properties. If the lenses are not injured one need not trouble himself about the worn appearance of the outside of the instrument; so much the more evidence that somebody has found it well worth using.

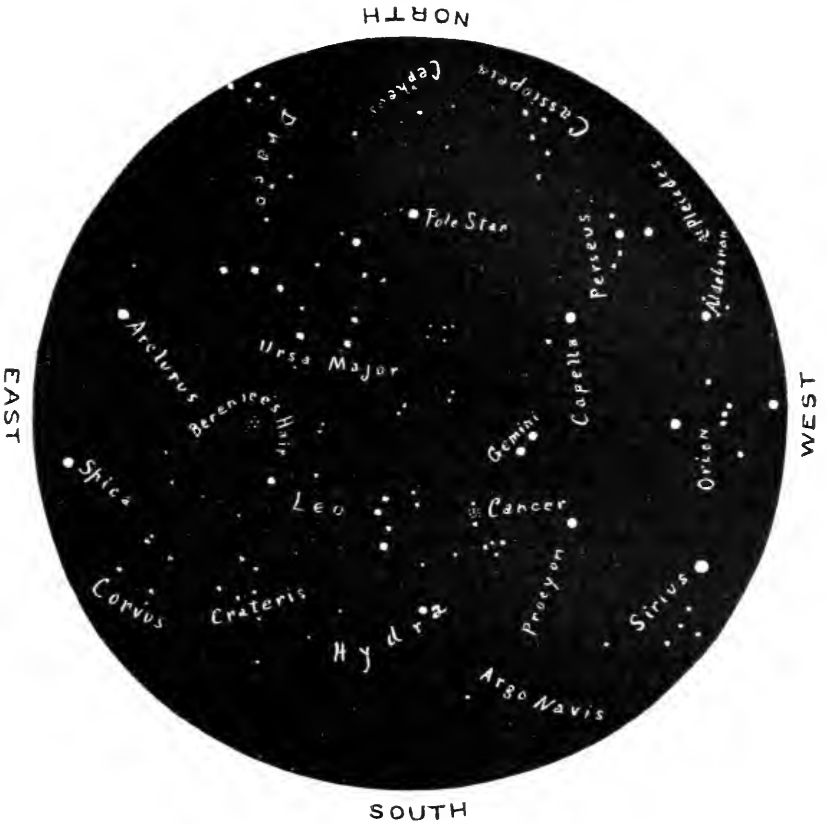
A good field or marine glass is in some respects better than an opera-glass for celestial observations. It possesses a much higher magnifying power, and this gives sometimes a decided advantage. But, on the other hand, its field of view is smaller, rendering it more difficult to find and hold objects. Besides, it does not present nearly as brilliant views of scattered star-clusters as an opera-glass does. For the benefit of those who possess field-glasses, however, I have included in this brief survey certain objects that lie just beyond the reach of opera-glasses, but can be seen with the larger instruments.

Having selected your glass, the next thing is to find the stars. Of course, one could sweep over the heavens at random on a starry night and see many interesting things, but he would soon tire of such aimless occupation. One must know what he is looking at in order to derive any real pleasure or satisfaction from the sight.

The circular map here given represents the appearance of the heavens, at 9 o'clock P. M., on or about the 1st of April. The center of the map is the zenith, or point overhead. The reader must now exercise his imagination a little, for it is impossible to represent the true appearance of the concave of the heavens on flat paper. Holding the map over your head, with the points marked East, West, North, and South in their proper places, conceive of it as shaped like the inside of an open umbrella, the edge all around extending clear down to the horizon. Suppose you are facing the south, then you will see, up near the zenith, the constellation of Leo, which can be readily recognized on the map by six stars that mark out the figure of a sickle standing upright on its handle. The large star in the bottom of the handle is Regulus. Having fixed the appearance and situation of this constellation in your mind, go out-of-doors, face the south, and try to find the constellation in the sky. With a little application you will be sure to succeed.

Using Leo as a basis of operations, your conquest of the sky will now proceed more rapidly. By reference to the map you will be able to recognize the twin stars of Gemini, southwest of the zenith and high up; the brilliant lone star, Procyon, south of Gemini; the dazzling Sirius, flashing low down in the southwest; Orion, with all his brilliants, blazing in the west; red Aldebaran and the Pleiades off to his right; and Capella, bright as a diamond, high up above Orion, toward the north. In the southeast you will recognize the quadrilateral of Corvus, with the singularly white star Spica glittering near the horizon east of it.

Next face the north. If you are not just sure where north is,



try a pocket-compass. This advice is by no means unnecessary, for there are many intelligent persons who are unable to indicate true north within many degrees, though standing on their own doorstep. Having found the north point as near as you can, look upward about forty degrees from the horizon, and you will see the lone twinkler called the north or pole star. Forty degrees is a little less than half-way from the horizon to the zenith.

By the aid of the map, again, you will be able to find, high up in the northeast, near the zenith, the large dipper-shaped figure in Ursa Major, and, when you have once noticed that the two stars in the outer edge of the bowl of the Dipper point almost directly to the pole-star, you will have an unfailing means of picking out the latter star hereafter, when in doubt.* Continuing the curve of the Dipper-handle, in the northeast, your eye will be led to a bright-reddish star, which is Arcturus, in the constellation Boötes.

* Let the reader remember that the distance between the two stars in the brim of the bowl of the Dipper is about ten degrees, and he will have a measuring-stick that he can apply in estimating other distances in the heavens.

In the same way you will be able to find the constellations Cassiopeia, Cepheus, Draco, and Perseus. Don't expect to accomplish it all in an hour. You may have to devote two or three evenings to observation, and make many trips indoors to consult the map, before you have mastered the subject; but when you have done it you will feel amply repaid for your exertions, and you will have made for yourself silent friends in the heavens that will beam kindly upon you, like old neighbors, on whatever side of the world you may wander.

Having fixed the general outlines and location of the constellations in your mind, and learned to recognize the chief stars, take your opera-glass and begin with the constellation Leo and the star Regulus. Contrive to have some convenient rest for your arms in holding the glass, and thus obtain not only comfort but steadiness of vision. A lazy-back chair makes a capital observing-seat.

You will at once be gratified by the increased brilliancy of the star as seen by the glass. If the night is clear it will glow like a diamond. Yet Regulus, although ranked as a first-magnitude star, and of great repute among the ancient astrologers, is far inferior in brilliancy to such stars as Capella and Arcturus, to say nothing of Sirius.

By consulting the little map of the constellation Leo, here given, you will next be able to find the celebrated star bearing the name of the Greek letter Gamma (γ). If you had a telescope, you would see this star as a close and beautiful double, of contrasted colors. But it is optically double, even with an opera-glass. You can not fail to see a small star near it, looking quite close, if the magnifying power of your glass is less than three times. You will be struck by the sur-

Leo

prising change of color in turning from Regulus to Gamma—the former is white and the latter deep yellow. It will be well to look first at one and then at the other, several times, for this is a good instance of what you will meet with many times in your future surveys of the heavens—a striking contrast of color in neighboring stars. You will then comprehend that there is more than one sense in which to understand the Scriptural declaration that "one star differeth from another in glory." Turn next to the star in the map of Leo marked Zeta (ζ). If your glass is a pretty large and good one, and your eye keen, you will easily see three minute companion stars keeping company with Zeta, two on the southeast, and one, much closer, toward the north. The nearest of the two on the south is faint, being only between the eighth and ninth magnitude, and will probably severely test your powers of vision. Next look at Epsilon (ϵ), and you will find near it two seventh magnitude companions, making a beautiful little triangle.

Away at the eastern end of the constellation, in the tail of the imaginary Lion, upon whose breast shines Regulus, is the star Beta (β) Leonis, also called Denebola. It is almost as bright as its leader, Regulus, and you will probably be able to catch a tinge of blue in its rays. South of Denebola, at a distance of nineteen minutes of arc, or somewhat more than half the apparent diameter of the moon, you will see a little star of the sixth magnitude, which is one of the several "companions" for which Denebola is celebrated. There is another star of the eighth magnitude in the same direction from Denebola, but at a distance of less than five minutes, and this you may be able to glimpse with a powerful field-glass, under favorable conditions. I have seen it well with a field-glass of 1·6-inch aperture, and a magnifying power of six times.

When looking for a faint and difficult object, the plan pursued by telescopists is to avert the eyes from the precise point upon which the attention is fixed, in order to bring a more sensitive part of the retina into play than that usually employed. Look toward the edge of the field of view, while the object you are seeking is in the center, and then, if it can be seen at all with your glass, you will catch sight of it, as it were, out of the corner of your eye. The effect of seeing a faint star in this way, in the neighborhood of a large one, whose rays hide it from direct vision, is sometimes very amusing. The little star seems to pop out into view as through a curtain, perfectly distinct, though as immeasurably minute as the point of a needle. But the instant you direct your eyes straight at it, presto ! it is gone. And so it will dodge in and out of sight as often as you turn your eyes.

If you will sweep carefully over the whole extent of Leo, whose chief stars are marked with their Greek-letter names on our little map, you will be impressed with the power of your glass to bring into sight many faint stars in regions that seem barren to the naked eye. An opera-glass of 1·5 aperture will show ten times as many stars as the naked eye can see.

Looking now westwardly from the Sickle of Leo, at a distance about equal to twice the length of the Sickle, your eye will be caught by a small silvery spot in the sky lying nearly between two rather faint stars. This is the famous Præsepe, or Manger, in the center of the constellation Cancer. The two stars on either side of it are called the Aselli, or the Ass's Colts, and the imagination of the ancients pictured them feeding from their silver manger. Turn your glass upon the Manger and you will see that it consists of a crowd of little stars, so small and numerous that you will probably not undertake to count them, unless you are using a large field-glass. Galileo has left a delightful description of his surprise and gratification when he aimed his telescope at this curious cluster and discovered what it really was. Using his best instrument, he was able to count thirty-six stars in the Manger. The Manger was a famous weather-sign in olden times, and Aratus, in his "Diosemia," advises his readers to—

> ". . . watch the Manger: like a little mist
> Far north in Cancer's territory it floats
> Its confines are two faintly glimmering stars;
> These are two asses that a manger parts,
> Which suddenly, when all the sky is clear,
> Sometimes quite vanishes, and the two stars
> Seem to have closer moved their sundered orbs.
> No feeble tempest then will soak the leas;
> A murky manger with both stars
> Shining unaltered is a sign of rain."

Like other old weather-saws, there is probably a gleam of sense in this, for it is only when the atmosphere is perfectly transparent that the Manger can be clearly seen; when the air is thick with mist, the harbinger of coming storm, it fades from sight.

Below the Manger, a little way toward the south, your eye will be caught by a group of four or five stars of about the same brightness as the Aselli. This marks the head of Hydra, and the glass will show a striking and beautiful geometrical arrangement of the stars composing it. Hydra is a very long constellation, and trending southward and eastward from the head it passes underneath Leo, and, sweeping pretty close down to the horizon, winds away under Corvus, the tail reaching to the eastern horizon. Its stars are all faint, except Alphard, or the Hydra's Heart, a second-magnitude star, remarkable for its lonely situation, southwest of Regulus. A line from Gamma Leonis through Regulus points it out. It is worth looking at with the glass on account of its rich orange-tint.

Coming back again to the Manger as a starting-point, look well up to the north and west, and at a distance somewhat less than that between Regulus and the Manger you will see a pair of first-magnitude stars, which you will hardly need to be informed are the celebrated Twins, from which the constellation Gemini takes its name. The star marked α in the map is Castor, and the star marked β is Pollux. No classical reader needs to be reminded of the romantic origin of these names.

A sharp contrast in the color of Castor and Pollux comes out as soon as the glass is turned upon them. Castor is white, with occasionally, perhaps, a suspicion of a green ray in its light. Pollux is deep yellow. Castor is a celebrated double star, but its components are far too close to be separated with an opera-glass, or even the most powerful field-glass. You will be at once interested by the singular *cortége* of small stars by which both Castor and Pollux are surrounded. These little attendant stars, for such they seem, are arrayed in symmetrical groups—pairs, triangles, and other figures—which, it seems difficult to believe, could be unintentional, although it would be still more difficult to suggest any reason why they should be arranged in that way.

Gemini

Our little map of Gemini will show you the position of the principal stars of the constellation. Castor and Pollux are in the heads of the Twins, while the row of stars marked in the map Zi (ξ), Gamma (γ), Nu (ν), Mu (μ), and Eta (η), marks their feet, which are dipped in the edge of the Milky-Way. One can spend a profitable and pleasurable half-hour in exploring the wonders of Gemini. The whole constellation, from head to foot, is gemmed with stars which escape the naked eye, but it sparkles like a bead-spangled garment when viewed with the glass. Owing to the presence of the Milky-Way, the spectacle around the feet of the Twins is particularly magnificent. And here the possessor of a good opera-glass can get a fine view of a celebrated star-cluster known in the catalogues as 35 M. It is situated a little distance northwest of the star Eta, and is visible to the naked eye, on a clear, moonless night, as a nebulous speck. With a good glass you will see two wonderful streams of little stars starting, one from Eta and the other from Mu, and running parallel toward the northwest ; 35 M is situated between these star-streams. The stars in the cluster are so closely aggregated that you will be able to clearly separate only the outlying ones. The general aspect is like that of a piece of frosted silver over which a twinkling light is playing. A field-glass will bring out more of the component stars. The splendor of this starry congregation, viewed with a powerful telescope, may be guessed at from Admiral Smyth's picturesque description : " It presents a gorgeous field of stars, from the ninth to the sixteenth magnitude, but with the center of the mass less rich than the rest. From the small stars being inclined to form curves of three or four, and often with a large one at the root of the curve, it somewhat reminds one of the bursting of a sky-rocket." And Webb adds that there is an "elegant festoon near the center, starting with a reddish star."

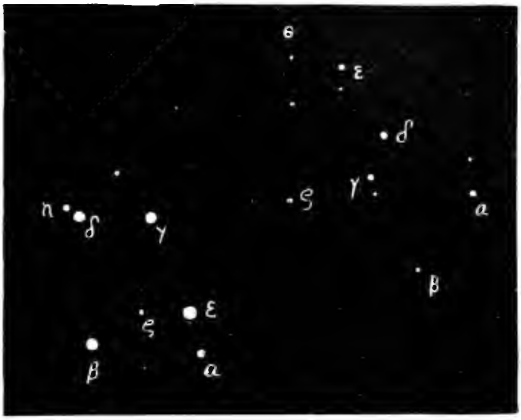
No one can gaze upon this marvelous phenomenon, even with the comparatively low powers of an opera-glass, and reflect that all these swarming dots of light are really suns, without a stunning sense of the immensity of the material universe.

The Twins are just now entertaining a visitor whose presence may cause some perplexity to the beginner in star-lore. The planet Saturn, in his great thirty-year journey around the sun, is passing nearly through the center of this constellation. You will see the planet a little west of the star marked Delta (δ) in the map of Gemini, and making a conspicuous triangle with Castor and Pollux. It outshines both of those stars, but its golden light is more steady than theirs. Turn your glass upon it, and the difference in the aspect of a planet and that of a star will at once become apparent.

The map will enable you next to find Procyon, or the Little Dog-Star, more than twenty degrees south of Castor and Pollux, and almost directly below the Manger. This star will interest you by its golden-yellow color and its brightness, although it is far inferior in the latter respect to Sirius, or the Great Dog-Star, which you will see flashing splendidly far down beneath Procyon in the southwest. About four degrees northwest of Procyon is a third-magnitude star, called Gomelza, and the glass will show you two small stars which make a right-angled triangle with it, the nearer one being remarkable for its ruddy color.

Sirius, Orion, Aldebaran, and the Pleiades, all of which you will perceive in the west and southwest, are generally too much involved in the mists of the horizon to be seen to the best advantage at this season, although it will pay you to take a look through the glass at Sirius. But the beautiful star Capella, in the constellation Auriga, may claim a moment's attention. You will find it high up in the northwest, halfway between Orion and the pole-star, and to the right of the Twins. It has no rival near, and its creamy-white light makes it one of the most beautiful as well as one of the most brilliant stars in the heavens. Its constitution, as revealed by the spectroscope, resembles that of our sun, but the sun would make but a sorry figure if removed to the side of this giant star. About seven and a half degrees above Capella, and a little to the left, you will see a second-magnitude star called Menkalina. Two and half times as far to the left, or south, in the direction of Orion, is another star of equal brightness to Menkalina. This is El Nath, and marks the place where the foot of Auriga, or the Charioteer, rests upon the point of the horn of Taurus. Capella, Menkalina, and El Nath make a long triangle which covers the central part of Auriga. The naked eye shows two or three misty-looking spots within this triangle, one to the right of El Nath, one in the upper or eastern edge of the constellation, near a third-magnitude star called Theta, and another on a line drawn from Capella to El Nath, but much nearer to Capella. Turn your glass upon these spots, and you will be delighted by the beauty of the little stars to whose united rays they are due.

El Nath has around it some very remarkable rows of small stars, and the whole constellation of Auriga, like that of Gemini, glitters with star-dust, as the Milky-Way runs directly through it.



Corvus and Crateris.

Let us turn back again to Denebola in the Lion's Tail. Now glance from it far down into the southeast, and you will see a brilliant star flashing not far above the horizon. This is Spica, the chief twinkler of Virgo, and you will find it marked on our circular map. Then look into the northwest, and at about the same distance from Denebola, but higher above the horizon than Spica, you will catch the sparkling of a large, reddish star. It is Arcturus in Boötes. The three, Denebola, Spica, and Arcturus, mark the corners of a great equilateral triangle. Nearly on a line between Denebola and Arcturus, and somewhat nearer to the former, you will perceive a curious twinkling, as if a cobweb spangled with dew-drops were hanging there. One might think the old woman in the nursery rhyme who went to sweep the cobwebs out of the sky had skipped this corner, or else that its delicate beauty had preserved it even from her housewifely instincts. This is the little constellation called Berenice's Hair. Your opera-glass will enable you to count twenty or thirty of the largest stars composing this cluster, which are arranged, as so often happens, with a striking appearance of geometrical design. This constellation has a very romantic history. It is related that the young Queen Berenice, when her husband was called away to the wars, vowed to sacrifice her beautiful tresses to Venus if he returned victorious over his enemies. He did return home in triumph, and Berenice, true to her vow, cut off her hair and bore it to the Temple of Venus. But the same night it disappeared. The king was furious, and the queen wept bitterly over the loss. There is no telling what might have happened to the guardians of the temple, had not a celebrated astronomer named Conon led the young king and queen aside in the evening and showed them the missing locks shining transfigured in the sky. He assured them that Venus had placed Berenice's lustrous ringlets among the stars, and, as they were not skilled in celestial lore, they were quite ready to believe that the silvery swarm they saw near Arcturus had never been there before. And so for centuries the world has recognized the constellation of Berenice's Hair. These time-honored legends, that have delighted the brightest minds in all countries and all ages, lend an interest of their own to the starry heavens, in spite of the fact that they make no impression upon the armor-plated souls of certain mathematicians who pretend to be the only astronomers, and who would sweep all constellations and mythologies together into limbo.

Look next at Corvus and Crateris, two little constellations which you will discover on the circular map, and of which we give a separate representation. You will find that the stars Delta (δ) and Eta (η), in the upper left-hand corner of the quadrilateral figure of Corvus, make a striking appearance. The little star Zeta (ζ) is a very pretty double for an opera-glass. There is a very faint pair of stars close below and to the right of Beta (β). This forms a severe test. Only a good opera-glass will show these two stars as a single faint point of light. A field-glass, however, will show both, one being considerably fainter than the other. Crateris is worth sweeping over for the pretty combination of stars to be found in it.

Arcturus and Spica, and their companions, may be left for observation to a more convenient season, when, having risen higher, they can be studied to better advantage. It will be well, however, to merely glance at them with the glass in order to note the great difference of color—Spica being brilliantly white and Arcturus almost red. We will now turn to the north. You have already been told how to find the pole-star. Look at it with your glass. The pole-star is a famous double, but its minute companion can only be seen with a telescope. As so often happens, however, it has another companion for the opera-glass, and this latter is sufficiently close and small to make an interesting test for an inexperienced observer armed with a glass of small power. It must be looked for pretty close to the rays of the large star, with such a glass,

URSA MINOR.

and, at nine o'clock in the evening, is below the large star. It is of the seventh magnitude. With a large field-glass several smaller companions may be seen, and a very excellent glass may show an 8·5 magnitude star almost hidden in the rays of the seventh magnitude companion.

With the aid of the accompanying map of Ursa Minor, which is the constellation to which the pole-star belongs, find the star Beta (β), which is also called Kochab (the star marked a in the map is the pole-star). Kochab has a pair of faint stars nearly north of it, about one degree distant. With a small glass these may appear as a single star, but a stronger glass will show them separately.

And now for Ursa Major and the Great Dipper—Draco, Cepheus, Cassiopeia, and the other constellations represented on the map, being rather too near the horizon for effective observation at this time of the year. First, as the easiest object, look at the star in the middle of the handle of the Dipper (this handle forms the tail of Ursa Major), and a little attention will show you, without the aid of a glass, if your eyesight is good, that the star is double. A smaller star seems to be almost in contact with it. The larger of these two stars is called Mizar and the smaller Alcor—the Horse and his Rider the Arabs said. Your glass will, of course, greatly increase the distance between Alcor and Mizar, and will also bring out a clear difference of color distinguishing them. Now, if you have a very powerful glass, you may be able to see the Sidus Ludovicianum, a minute star which a German astronomer discovered more than a hundred and fifty years ago, and strangely enough, taking it for a planet, named it after a German prince. The position of the Sidus Ludovicianum with reference to Mizar and Alcor, is represented in the accompanying sketch. You must look very sharply if you expect to see it, and your opera-glass will have to be a large and strong one. A field glass, however, can not fail to show it.

URSA MAJOR.

Sweep along the whole length of the Dipper's handle, and you will discover many fine fields of stars. Then look at the star Alpha (α) in the outer edge of the bowl nearest to the pole-star. There is a faint star, of about the eighth magnitude, near it, in the direction of Beta (β). This will prove a very difficult test. You will have to try it with averted vision. If you have a field-glass, catch it first with that, and, having thus fixed its position in your mind, try to find it with the opera-glass. Its distance is a little over half that between Mizar and Alcor. It is of a reddish color.


MIZAR, ALCOR, AND THE SIDUS LUDOVOCIANUM.

You will notice nearly overhead three pairs of pretty bright stars in a long, bending row, about half-way between Leo and the Dipper. These mark three of Ursa Major's feet, and each of the pairs is well worth looking at with a glass, as they are beautifully grouped with stars invisible to the naked eye. The letters used to designate the stars forming these pairs will be found upon our little map of Ursa Major. The scattered group of faint stars beyond the bowl of the Dipper forms in the Bear's head, and you will find that also a field worth a few minutes' exploration.

But, after all, no one can expect to derive from such studies as these any genuine pleasure or satisfaction unless he is mindful of the real meaning of what he sees. The actual truth seems almost too stupendous for belief. The mind must be brought into an attitude of profound contemplation in order to appreciate it. From this globe we can look out in every direction into the open and boundless universe. Blinded and dazzled during the day by the blaze of that star, of which the earth is a near and humble dependent, we are shut in as by a curtain. But at night, when our own star is hidden, our vision ranges into the depths of creation, and we behold them sparkling with a multitude of other suns. With so simple an aid as that of an opera-glass, we penetrate still deeper into the profundities of space, and thousands more of these strange, far-away suns come into sight. They are arranged in pairs, sets, rows, streams, clusters—here they gleam alone in distant splendor, there they glow and flash in mighty swarms. This is a look into heaven more splendid than the materializing imagination of Bunyan pictured ; here is a celestial city whose temples are suns, and whose streets are the pathways of light.

A COLLECTION of drawings by the Jesuit botanist, Camelli (1661–1706), illustrating his lists of plants of the Island of Luzon in Ray's "Historia Plantarum," exists in good preservation in the library of the Jesuits' College at Louvain. It contains two hundred and fifty-seven autograph plates, with five hundred and fifty-six figures of plants, and three plates, with nine figures relating to zoölogy. It was obtained at the sale of the library of Jussieu, and bears annotations in his handwriting.

SOCIAL AND PHYSIOLOGICAL INEQUALITY.

By HENRY DWIGHT CHAPIN, M. D.,

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THE subject of the hour is the social problem. Viewed in the light of the pressing questions demanding settlement—questions really of life and death—the new science of sociology overshadows all others in importance. The air is full of the angry clamor raised by different cliques and classes, all arguing from the standpoint of their own interests. The strain to which society is thus subjected must be relieved, if possible, by broad and unprejudiced reasoning in the line of causes. In this manner only can the possibilities and limitations of relief be suggested. It is evident that in the present state of society many are hopelessly worsted in the effort to gain, not a competency, but a moderate sustenance. Numerous irrelevant causes and cures are constantly being proclaimed for this glaring evil, leaving the essential causes untouched. The mutterings of discontent heard on all sides have their basis largely in the belief that the fault lies in a friction resulting from an artificial social order. Economic laws are really, at bottom, the outcome of physiological laws and conditions. Assuredly, laws of Nature are fundamental and must underlie economic laws ; the latter may be modified, but not essentially altered by artificial social relations. Certain reformers are fiercely attacking our social system as the ultimate cause of misery, entirely overlooking the fact that social conditions are merely the resultant and aggregate of individual characteristics. As long as these remain unchanged, society may be repeatedly disintegrated, but the same abuses will as regularly spring up. Those who are demanding more social equality must first see to it that there is more individual equality. It is a favorite corollary of our political system that all men are born equal. Unfortunately, legal equality is not physiological equality. In fact, there is no such thing as equality. Much of the restlessness of the age is the endeavor to institute formulas and laws of equality while no such real element exists. Two stupendous factors are present in all life, physical as well as mental—heredity and environment. These all-controlling influences are present, for good or evil, in varying proportions in different lives. With the generation of life heredity, whose mysterious effects we must recognize without understanding, has done its best or worst for the beginning existence ; its potency has been in the past, acting perhaps through long reaches of time. With commencing life comes in the new element of environment,as the complement of heredity, to enhance the evil trait, or perhaps obliterate it ; too often to sow the seeds of physical and mental weakness in a constitution that was given a healthy start. To insure correct environment and habit, particularly in the early years of life, is of vital importance to the well-being and efficiency of the individual. This, unfortunately, is not, and in many cases can not, be done. Hence the fearfully unequal physical, mental, and moral equipment of mankind, that allows the minority to have too much, the majority too little, of the world's necessities and comforts.

This question, however, has a broader interest than is merely involved in economics. One of the ultimate aims of life upon earth is the perpetuation of the species, an essential incident of which is the struggle to live. This aim of life in Nature is seen in all creations, from trees and insects up to man. Under the term "struggle of life" are included many complex factors. Such problems as how to conserve and prolong life, how to lower the death-rate in children, how to produce good hereditary development, how to strengthen the bodies and minds and enlarge the spiritual bounds of men—all these, and many other questions, are included in a conception of this struggle. It is evident that those are the best conditions of life that lead to the highest development of the physical, mental, and moral faculties, and the largest and best growth of the species. The all-important question is this: How are the present conditions of society favoring and how subverting a successful struggle on the part of many of its members? How far do they tend to cripple the best development of life? This larger and more absorbing question includes the narrower one we are here discussing, as to the observed inequalities of society. It is too large a theme for a single essay. A brief glance at the varying conditions that produce social inequality may be of interest.

1. Unequal Physical Development.—As a rule, the more bodily vigor a person possesses the better will be his chance of getting on in the world. Many people fail because they have not the physical strength for prolonged and successful effort. What fair chance, then, has a child beginning life in an overcrowded tenement-house, all of whose bodily functions are from the first contaminated? The cells, of which the human body is but an aggregate, might at this time by healthy surroundings and physiological living, have marked upon them an impress of lasting vigor; by foul air and improper nourishment they likewise have sown in them the seed of an early degeneration. After a large dispensary experience, I have no hesitancy in saying that the great majority of children brought up in the tenement-houses of New York are, in greater or less degree, affected by a constitutional taint, usually scrofulous or rachitic. Such a vicious condition grows by what it feeds on. Each generation will get worse from the addition of hereditary influences to the faulty environment, unless something is done to check these evils. It is not difficult to foresee what will result in a community if a large proportion of its inhabitants are, by reason of their physical organization, seriously handicapped in the struggle

for existence. The dirt and discomfort, in the midst of which thousands live at our very doors, would astound many among the better classes who are always wondering at the shiftlessness of the poor. A suggestive paper was read before the British Medical Association in 1885, showing the large influence that bodily comfort has in lowering the death-rate. The same influences that can increase mortality among the poor are also operative in curtailing their efficiency and usefulness.

2. Unequal Mental Development.—Some of our modern materialistic philosophers would have us believe that mind is a function of body—a sort of secretion of the brain. While this bald conception will not commend itself to many, it certainly is true that mind acts through nervous organization, the integrity of which stands in a direct relation to the most efficient mental manifestation. In the physical growth of man a completely developed brain is the highest type of organization. The normal action of the mind is much modified by the health or disease of the nervous elements, which are constantly affected by the condition of the vital organs. As a rule, therefore, an efficient mind is an accompaniment of a well-acting body. It is true that brute strength is frequently seen accompanied by signs of only inferior mental life, but in such cases the evolution of the higher nerve-centers, together with proper education of the mind, has been in abeyance for generations, with resulting stagnation. In the intensely close competitions of the present day a certain mental acumen is absolutely necessary to attain any measure of success. The man who has not the mental equipment to figure a close bargain will as inevitably succumb to the one who can, as the bird with the longest beak or strongest claw will vanquish its weaker antagonist. The physically and mentally weak inevitably yield before the law of the survival of the fittest in our modern civilization. This law may be more immediately apparent in its action on physical than on mental life, yet it is as real in one as in the other sphere. Hereditary taint and bad hygienic surroundings produce in many such a condition of weak lungs as to develop, by the ordinary and necessary exposure of life, the disease known as consumption. Death results, and such people die because their lungs are not fit, or strong enough, to survive in the conditions of their environment. Our dispensaries and hospitals are now crowded with such unfortunates who are bound to succumb, sooner or later, to this unerring natural law. Persons with vigorous lungs, who can do the world's work and thrive under conditions that destroyed the former class, are living examples of a physical survival of the fittest. But there is just as much a mental as a physical exemplification of this law. The dull wit can not be made to accomplish that which is easily done by the acute mind—can not live the same life. A man who digs a canal must, in order to do the only thing within his capacity for earning a living, become the tool of the mentally "fitter" man—the engineer—who has the intellectual skill to plan such a work. Disgusted at his

uneven lot, the laborer would often strike down the man whose mental superiority makes possible the earning of his bread. Trades-unions in attempting to reduce all work and wages to a dead level, in spite of the varying abilities of different workingmen, are striving to accomplish a reversal of natural law. As for any permanent success in this matter, they will find it about as difficult to change the operation of the law of the survival of the fittest, as the law of attraction of gravitation. A state or society might as well decree that the man with the strong lungs should not live any longer than the one with weak lungs, as attempt to restrain the fertile, active mind, and limit its performance by the capacity of the dull brain. At the same time, we should strive to find out the preventable causes of mental as well as of physical inferiority.

The child from the swarming tenement-house, after a desultory and unpractical schooling, is quickly transferred to shop or factory, where the struggle of life must be begun on a pitiably insufficient physical and mental training. A practical, industrial education does not appear to be within the conception of our public schools. This is just the line of education that would make them useful to the poor. We are hearing much at present of the dignity of manual labor; but work of the hands, unless in a measure directed by the head, is rather a lame accomplishment. Workingmen often show an inability to get along, because they have not sufficient mental equipoise to direct their affairs properly, as well as their work. They are continually being victimized by political manipulators and social quacks from this cause. Social conditions that keep men and women hopelessly toiling all their lives on one low plane are lamentable, but biological law shows us that heredity and a terribly unfavorable environment have of necessity precluded the physical and mental acuteness necessary to reach a higher level.

3. Unequal Moral Development.—In character, no less than in body and mind, do we see vast differences among men. From the perfect activity of a well-balanced will to the uncertain energy of a vacillating character, there are innumerable variations. Such gradations do not stand in any ratio to intellectual culture. Moral power depends largely upon material environment. It does not flourish with filth or famine. Self-respect, that fundamental necessity for the higher attributes, can not well exist in rags and dirt. Moral rectitude is with difficulty conserved when the contact of individuals is too close. The excessive overcrowding so often seen in the tenements of great cities is as destructive of virtue as of physical health. I have seen sexual diseases engendered, even in childhood, that will not only cripple the development of the individual, but be propagated to future generations. Probably the most prolific cause of vice in densely populated centers is the condition here noted. This is only one aspect of a great subject. It is not necessary to believe that moral nature has been

acquired by the slow processes of evolution to appreciate the preponderating influence of heredity in the manifestation of will-power and kindred phenomena. Two individuals may start in life apparently with equal chances and hindrances. One succeeds, the other fails; one is only stimulated by obstacles, the other is disheartened and conquered by them; one has inherent possibilities in his nature that are utterly absent in the other. The mysterious potentialities of different natures are often more easy of recognition than of explanation. There are many peculiar and diverse ways in which the action of the moral nature is exhibited, according to its development, in human affairs. Thus some men display most exemplary conduct in certain relations of family and society, but show an utter absence of the moral sense in dealing with competitors.

There are, unfortunately, at the present time, too many object-lessons exemplifying a strangely irregular moral development. Men who calmly exhibit the greatest depravity in pushing schemes for their own interest, recklessly bribing officials and buying legislators, may yet show apparently the record of a most proper private life. A man who wrecks a bank, thereby spreading distress and ruin wide-spread, is found to be the kindest of fathers. The evil done by forcing a corner in the market that will put some of the necessaries of life beyond the reach of the needy multitude, can not be compensated for by subscribing to a charity. Railroad-wrecking and dishonest speculation form an incongruous mixture with benevolence. Qualities that are subversive of all civic virtues and tend to the very disintegration of society, appear to flourish by the side of a sort of goodness, finding expression, perhaps, in one or two directions.

The faculty of the mind, as well as the organ of the body, that is used the most, undergoes the highest development and works with preponderating efficiency. If there is an absence of a properly regulated human and moral feeling to hold a check on such excessive keenness, the results are unfortunate. The over-development of acquisitiveness and the under-development of certain moral faculties, have enabled individuals to distance competitors and crowd better men to the wall. Some men may have too high a sense of honor to compete successfully with others not so endowed. Doubtless, many of the shiftless and lazy like to consider that they are too honest to succeed. But often this is true of better men. Intense selfishness is too exclusively the mainspring of endeavor in our modern civilization. While the inferior development of physical and mental functions keeps a large proportion of mankind in unequal subjugation to the minority, the under-development of certain parts of the moral nature is actually an aid to worldly success. This is a pregnant thought, and shows how the development theory can throw side-lights on all angles of a social question.

There is, then, a direct relation between an individual's heredity and environment and the complete soundness and efficiency of that individual. In the struggle for existence, where all the conditions for successful and vigorous life have unavoidably been present in poorest degree, it inevitably follows that competition with more vigorous minds and bodies must result in hopeless defeat. Hence the absurdity of most of the ideas advanced for the relief of social wrongs. Appeals are being continually made to Government to remedy this unfortunate state of affairs. But Government can not help or prevent the operation of natural law. These laws of Nature have been permanently established by the Deity, and no set of men acting temporarily as figure-heads of society can alter their operation. Human life, to be satisfactory, must be conducted according to a knowledge and in conformity with these laws. All that Government can do and should do is to strive to furnish and insist upon the most favorable natural conditions or environment possible for the people—in other words, give them the best chance. Beyond this, nothing can be done by Government. It can not alter a man's ancestors. The Scriptures, as well as the state, tell us to work out our own salvation.

No altered laws will compensate for defective knowledge or will-power in the regulation of human affairs. A man or a sect with a panacea is always popular. It is disagreeable to face the fact that the causes of most of the ills of life are complex and often difficult of removal. Universal specifics are thus numerous. The statement that people like to be humbugged is as true of social as of physical ills. They shift from one to another of the many quacks who can point to a single and sure road out of all their troubles. Two leading theories have been advanced to reorganize society—socialism and communism. As a sentiment, socialism is in keeping with the highest conception of the relation of man to man; as an organization, it is the enemy of society, since it is not in correlation with the present structure and development of human nature. The underlying sentiment of socialism claims that every man should have a fair opportunity to make a comfortable living and a chance to develop what is best in himself and family. At present this is impossible in many cases. It will continue to be impossible until the weak can be strengthened by more favorable environment for a more efficient struggle in life.

Communism recognizes the evils resulting from the fearfully unequal distribution of wealth, and would force a general division. As human nature is now constituted, this is an idle conception. The wealth that is universally distributed and equalized to-day will to-morrow be again in the hands of the few. Legislators can not prevent this unerring economic law due to fundamental differences in men's development and equipment. Beer-garden philosophers would bring everybody to a level—the lowest level—well exemplified in themselves. In the different strata of society, if men could only be leveled from below up in physical and mental weakness and inefficiency; from above down in unscrupulous sharpness with lacking moral sense, society would be in a condition of more stable equilibrium. No radical alteration in social order will be possible until human nature has slowly been prepared for it by a corresponding alteration. Social reconstruction must be preceded by a reconstruction of man's nature. Has modern society, then, nothing to answer for? Can it calmly point to the inexorable laws of evolution as responsible for social wrongs? Assuredly not. Society must be held in a measure responsible for the crippling environment of so many of its members. The labor that is treated as a pure commodity, to be purchased in the lowest market, will be apt to sink to that level. The manufacturer sees in the excessive division of labor a way to quick profits; hence even pins must be made, from head to point, by different artisans. This plan may produce sharp pins, but it makes dull men, whose children will probably be duller yet.

Trades-unions and labor organizations sin more in this respect, however, than the greediest capitalists. The leaders by sternly repressing all efforts of the men to better their condition, by checking all ambition to become skillful, by stopping apprentices from learning trades, and by striving to produce a general level of remuneration, are reducing laborers to the condition of slaves.

Modern industrial civilization is adapted to make the sharp sharper and the dull duller, which is only another way of saying concentration of wealth and diffusion of poverty. Society should strive to atone for its fearful inequalities, not by division and almsgiving, but by strengthening the weak for more successful effort. It must aid the poor and unfortunate by giving them a chance to help themselves. Giving to charities is esteemed generous; it is a truer generosity for the keen man of affairs not to ruinously undersell his less acute neighbor and thus perhaps force him to depend on charity. Above all, no social relief that is not based upon essential causes can be permanently successful. Social reformation that is not in harmony with the underlying laws of Nature will always be a failure. It must follow in the lines indicated by a logical study of the sciences of biology, physiology, and even of pathology. Social law must conform to natural law. All artificial adjustments only complicate existing troubles in leaving untouched the real causes of these troubles. If several men are in a boat that capsizes, all will struggle to reach the shore, but the man who can not swim will sink, although all the legislatures of the world forbid death by drowning. He sinks in obedience to a natural law, attraction of gravitation, the operation of which, to his destruction, he is not expert enough to avoid in an unaccustomed environment. If society will prevent such accidents, it must do it in the natural way of strengthening its members and teaching them how to swim, plainly showing the possible consequences of such a neglect, and not by issuing fiats against misfortune. This is the natural as distinguished from the artificial method of dealing with a social question. A persistent struggle for continuous and successful life, with intervening accidents or catastrophes, always possible, forms the ever-present condition of physical as well as of social living. Much of our daily energy is necessarily expended in repairing continual bodily waste that the process of life entails, in fighting off disease or avoiding accidents. Life can truly be defined as a struggle for existence. With reference to life in society, Carlyle, in his terse, strong style, puts it thus: "No man lives without jostling and being jostled; in all ways he has to elbow himself through the world, giving and receiving offense. His life is a battle, in so far as it is an entity at all." Sociology must try and determine why many fight such a losing battle, by seeking closer counsel with the laws and teachings of physiology.

The lazy, inefficient, and even the criminal classes, are an inevitable by-product of our complex modern civilization. They are not accidents, but accretions. They are developed by laws that it is the duty of social science to discover and obviate, instead of indulging in idle moralizing. These laws must be evolved by a slow and patient study of social phenomena interpreted by biological methods. When these laws are understood, it will be seen that a sound education is the measure of relief. I use this word in no narrow or conventional sense, but meaning the development of the whole being in the line of the highest strength and efficiency of the various parts. Every effort of the philanthropist, the social reformer, and the Government must be invoked to prevent degradation and degeneration in the poorer classes, and raise them to a better status. The laws of healthy development must be taught, and the consequences of their neglect in the habits of life be shown.

A young man who will marry early and raise a large family in a closely populated center will inevitably involve himself in poverty and his family in misery. Such apparent facts must be laid before the young in time to prevent mistakes that can not be rectified. One of the unfortunate factors in the social question is that the poorest and often the physically unfittest classes are usually the most prolific, for which they sometimes receive needless and undeserved praise. It is the business and duty of Government to do all in its power to prevent or mitigate any environment that all experience shows will produce not only physical and mental inefficiency, but sufficient degradation of the moral sense to make criminals. To this extent can Government profitably interfere in a social question. It may be contended that Government is not a philanthropic institution, and hence it is without its scope to consider means to elevate the shiftless and unfortunate. It may also be argued that Government can not consistently interfere even with the degradation of people without assuming a right to regulate all their affairs. But, outside of all theoretical objections, no one will deny the right and duty of Government to look out for itself. Self-preservation is a law that applies to governments as well as to individuals. Any factors that threaten the stability of organized society, threaten at the very same time the very existence of governments. Hence, when scientific and hygienic laws show that certain environments degrade and degenerate men, they must be prevented, although appearing to interfere with the liberty of the subject. No legal shibboleth must be allowed to stand in the way of such action. Government in its function of preserving itself, and looking out for the best good of the majority, must prevent a minority from living in any way it can take cognizance of that plainly lessens their health and efficiency.

In spite of caste, society is homogeneous. One section can not suffer long without affecting all. If one part is much diseased, the healthy part will sooner or later feel the infection. More equable health will equalize opportunity. Political communism is a dream of agitators. The toiling, weary, worsted masses look in vain to such a chimera. Deliverance must come from within. Our popular agitators are impatient of a few weeks' delay in righting the wrongs of society. Reform of this kind that is measured by months is superficial and uncertain. Nature in progressing is prodigal of time, but operates with certainty and thoroughness.

INFECTION AND DISINFECTION.

By ROBSON ROOSE, M. D.

THE enormous variety of subjects contained in medical literature necessitates the use of a corresponding number of terms, the majority of which have a certain and well-known meaning; but it would be difficult to find two words more wanting in the element of precision, and more loosely used, than those placed at the head of this article. The general public, indeed, solve all difficulties by connecting with the word infection the idea of something "catching," i. e., something that can be propagated from one person to another, and disinfection is correspondingly regarded as the means whereby such propagation can be hindered. It must be admitted that this simple view is quite correct so far as it goes. It of course disregards all questions as to the nature of infection, and the reason why some diseases spread from person to person and others do not, and it accepts without doubt the belief that disinfection is generally attainable, and by comparatively simple means. In cases especially where the use of some well-advertised material is found to neutralize or mask an unpleasant odor, the completeness of the disinfection is looked upon as absolutely certain.

In medical writings the confusion has been still further increased by the use of the words "contagion" and "contagious" in describing those diseases which were considered to spread from one person to another by contact. "Infection" and "infectious" were limited to the cases in which the poison of the disease was supposed to be conveyed by the atmosphere from the sick person to those at a greater or less distance from him. Accordingly, we used to hear of a disease being contagious but not infectious, and *vice versa*. The distinction is, however, a purely artificial one, and is not sustained by facts, for many of the contagious diseases can be propagated indirectly—that is, without actual contact between the person who yields the poison and the person who receives it. Take, for example, diphtheria: it assuredly spreads by contact, and is therefore contagious, and no less positively is the poison capable of being disseminated through the atmosphere and infecting those who inhale it. So, too, with small-pox. If its virus be introduced under the skin of a person unprotected by vaccination or a previous attack, he will almost certainly suffer from the disease, and the same result would follow were such a person to be in close attendance upon a small-pox patient. In the latter case, the poison floating about in the atmosphere would get into the system through the lungs, and this is practically just as much an example of *contact* as if the poison were artificially introduced through the skin. It is therefore better to consider the terms "infection" and "contagion" as practically synonymous, and they will be so used in the remarks that follow.

To show what is implied by an infectious disease, let me take a typical example and contrast it with another disorder well known to be non-infectious. A young adult, previously in good health, is suddenly attacked by such symptoms as chilliness, soreness of throat, and evidences of derangement of the stomach. There is nothing characteristic about these symptoms; but let us suppose that on the following day there are high fever, dryness of skin, headache, giddiness, etc., and that in a few hours a scarlet rash appears, first on the chest, and then spreads over the body. All the symptoms become worse, and for ten or twelve days the patient is very ill. After this period, in favorable cases, a change takes place for the better, the rash dies away, and all the other symptoms gradually subside. In from four to six weeks, supposing that there are no complications, the patient regards himself as well. Such, in a few words, is the course of a mild case of scarlet fever, which may be considered as a typically infectious disease. Now suppose that our patient is treated in a house where there are several other young people who have never suffered from the disease. We know from experience that unless the most minute precautions are taken, the majority of these persons will exhibit similar symptoms. It is also well known that if any of these patients, supposed to have partially recovered from the disease, change their place of abode and go among other friends, the latter will run great risk of being attacked, and that the disease may thus spread *ad infinitum.* This capacity of propagation, the possession of which is as certain as anything can possibly be, suggests the inquiry as to the manner in which the original patient of our series became infected. He in his turn must have taken the disease from some one else, but it is quite possible that he has never been within a mile of a scarlet-fever patient. In many such instances it is impossible to get any clew to the original case, but it sometimes happens that evidence is forthcoming to the effect that days or weeks, or even months before, a person convalescent from the disease has occupied a room of which our patient was afterward a tenant, or that some article of clothing which once belonged to patient number one has been handled or worn by the person whose case we are considering. It is evident that there must often be great difficulties in prosecuting such an inquiry.

Let us now take an example of a non infectious disease, and notice how it contrasts with the one we have just described. A young adult, previously in good health, becomes sensible of a feeling of heat, alternating with chilliness, and perhaps shivering, and slight pains in the limbs. In a day or two there is more or less fever and thirst, and some of the larger joints are swollen and very painful, while the skin covering them is much reddened. The pain and fever are the principal symptoms; but there are often others, a description of which is unnecessary for our present purpose. The complaint lasts an indefinite time, but, even in the absence of treatment, usually subsides within six weeks. Such, in a very few words, is the course of rheumatic fever or acute rheumatism.

These two diseases, scarlet fever and rheumatic fever, have much in common, but there are sharp points of difference between them. In both fever is a prominent symptom, and, in addition to the display of local symptoms, the whole system is evidently affected. The differences, however, are still more important. Scarlet fever is eminently infectious. The air which surrounds the patient becomes contaminated and highly charged with the poison, and persons breathing it run great risk of becoming affected. In a case of rheumatic fever, although the secretion from the skin is generally very copious and peculiar in character, so that the sense of smell is strongly appealed to, there is no such risk; the disease can not be conveyed from the patient to those around him, however close the attendance and however defective the ventilation of the room. Infection from a previous case is, therefore, never thought of in connection with rheumatic fever, though the actual nature of the poison which causes the disease is as yet unknown. The attack is often excited by exposure to cold and wet, circumstances which play no part in the causation of scarlet fever. There is at least one more important difference between the two diseases: scarlet fever very rarely, indeed, occurs a second time in the same patient, and the symptoms never become chronic; rheumatic fever, on the other hand, is very prone to recur, and in not a few cases the original attack merges into a chronic state of suffering, which may continue for months or even years.

I have taken scarlet fever as a representative of the class of infectious diseases, the cause of which is the contamination of the system by some specific poison, and I have sketched in a few words the main symptoms which result. For our present purposes the important points are the contagious or infectious character of the disease, and the proofs that the contagious material multiplies within the system which it has invaded, and from which it sallies forth in quest of other victims. There are, unfortunately, not a few diseases belonging to the same category as scarlet fever, the principal being small-pox, measles, typhus, influenza, whooping-cough, diphtheria, typhoid, and cholera. With regard to all these it may be stated that they are all separate and distinct as regards causation. A case of scarlet fever never gives rise to small-pox in those exposed to infection, neither does any one of the above diseases ever pass into another. There are other subordinate distinctions: the poison of scarlet fever, contained presumably in detached particles of skin, clings for months to articles of clothing, especially woolen ones; that of small-pox may be collected from the eruption and preserved for years between pieces of glass; that of typhus is easily rendered innocuous by free ventilation. All these peculiarities—and many more might be cited—point to important differences in the nature of the infectious materials.

What this infectious material really is has often been keenly debated since medicine became a science, and at the present time is the question which most closely occupies the minds of medical investigators. Merely to enumerate the inquiries, and to describe the experiments and the theories based thereon, would fill a volume; but it is not to be wondered at that this subject should have excited so much attention when we reflect upon the prevalence and fatality of the diseases in question, and upon the comparatively slight influence which treatment exercises upon their course. On the other hand, experience clearly shows that their prevention is not only possible, but in some cases easily accomplished. The knowledge of the causes of these diseases would indicate the proper preventive measures, or at any rate the direction which such measures should take, and hence a discovery of the cause in any given case at once yields practical results. When we know what causes infection, we can apply disinfection with every prospect of success. Without such knowledge success, if attained, must be accidental rather than otherwise. The nature of the contagious agencies, and the medium through which they spread, are the most important points in connection with the subject of infection.

There is strong evidence in support of the view that these contagia are actual living things. Formerly the opinion was universally held that infectious diseases were caused by foul air, and the effluvia connected with putrid decomposition were regarded as a sufficient cause for the development of fever, small-pox, etc. It can not be denied that gaseous matters, notably sulphureted hydrogen, may act as poisons and cause many serious symptoms, but it has never been shown that infectious diseases originate in this manner. It is contrary to all that chemistry teaches us, that sulphureted hydrogen or ammoniacal vapors inhaled by the lungs should increase within the body and cause it to become a center of infection ; and we know likewise that ordinary poisons—e. g., arsenic or morphia—fatal as their effects may be to one individual, have no power of increase and propagation after being once taken. It is therefore evident that the poisons of infectious diseases must be something of an entirely different nature. We know that they multiply in the system to an almost infinite extent, and that every one of the myriads of atoms thus developed is as potent for evil as the atom from which it originated. The possession of this and other properties clearly indicates that the contagious agencies are independent living organisms, capable of growth and reproduction. It has long been known that certain diseases of the skin—e. g., ringworm—are caused by the presence of parasites, which very rapidly increase, and can be easily recognized under the microscope.

In the case of some three or four of the infectious diseases it would seem that the poison has really been discovered. On examining vaccine matter, the contents of the pocks in small-pox, and discharges in glanders, the microscope shows a vast number of infinitely minute particles, which appear as glistening points. Some of these are even less than the fifty-thousandth of an inch in diameter, and it therefore follows that very high powers are necessary for their detection. Such particles, obtained from vaccine lymph, have been washed in water ; the water when inoculated did not produce any effect, but the washed particles were found to have retained their potency. It seems fair to infer that the contagious agents of the other infective diseases would resemble in their physical characters that of vaccine, and the nature of such particles is the important problem that offers itself for solution. They are supposed by some, and notably by Dr. Beale, to be of an animal origin, and to consist of elementary living matter, termed *bioplasm*. Such particles may be easily transferred from an infected to an uninfected organism, in which they will manifest their own specific powers, and grow and multiply almost indefinitely, exciting in their new home a series of changes resembling those which characterized their presence in the one from which they were derived. This account is certainly correct as regards the virus of vaccine, but it does not precisely define the nature of the particles or tell us anything of their origin. Dr. Beale, however, states that particles of contagious bioplasm are not generated in the organism of the infected animal, but are introduced from without, and were originally derived by direct descent from the bioplasm of the body of man or animal. He regards them in fact as particles of degraded bioplasm. This theory is not in favor, or rather is not fashionable, at the present time. One objection to its validity is constituted by the fact that particles of living animal matter die very rapidly after they have escaped from the body, whereas many contagious germs preserve their vitality and capacity for evil for a very long time.

Another theory which was promulgated some twenty years ago was to the effect that the contagious particles are of the nature of those low vegetable organisms which are termed *fungi*. This view gains support from the manner in which these bodies increase in number when planted in a suitable soil, and the power which they possess of decomposing many organic substances. The fact, already referred to, that several diseases of the skin and hair in men and animals are undoubtedly due to fungi, also tends to recommend this theory. Recent experiments, however, have shown that these organisms, capable as some of them are of growth and development on the *surface* of the body, do not possess the power of growth and reproduction *within* the body, and it is therefore unlikely that they should be the causes of disease in which the system is charged with poisonous materials.

A third theory is one which is extremely popular at the present day, advocated as it is by investigators of the highest repute. It is almost needless to say that I refer to the view which credits certain minute organisms, termed *bacteria*, with the power of causing the infectious diseases—that is, with being in themselves the poisonous agents. So firm is the hold that this view has obtained that "disease-germs" and "bacteria" are used as though they were synonymous terms. It is, moreover, probable that more experiments have been made with reference to bacteria than on any other subject whatever.

The term "bacterium" signifies a rod, and many of these organisms are minute, rod-shaped bodies. They or their germs are very widely diffused throughout nature; they swarm in the air and in water, especially if containing organic matter, and are likewise found in great numbers within the bodies of men and animals. Any one who possesses a microscope with a magnifying power of five hundred diameters can readily examine a very common form of bacterium. It is only necessary to take a glass of ordinary water from a spring or river, and to leave it in a room exposed for some days to the air. A thin coating, looking like a deposit of fine dust, is formed on the surface of the water; this dust consists of myriads of bacteria, which are readily seen when a drop of the water is examined. The bacteria are found to be in several stages of transformation: some are in long, jointed rods, others represent one or more detached portions of these rods, and others appear as extremely minute, rounded particles. The rods are capable of movement, and they are seen to wriggle through the fluid like small eels or snakes. The minute, rounded particles are the spores, which eventually become rod-shaped bodies.

The peculiar interest connected with this simple experiment is due to the fact that minute organisms closely resembling those just described are found in the bodies of patients suffering from acute infectious diseases, and the question naturally arises as to the relation which exists between the organisms and the symptoms. Are the former the cause of the latter, or is their presence a mere coincidence? Another suggestion is that their presence is the result of the disease. If the symptoms are really caused by the presence and action of the bacteria, it would follow that differences must exist between the organisms found in different diseases. Great and manifold difficulties attend such investigations; it is sufficient here to notice the extreme minuteness of the organisms, necessitating the use of the highest powers of the microscope for their detection. Moreover, as already stated, bacteria are found in large numbers in the bodies of healthy persons, and some of these organisms very closely resemble, if indeed they are not identical with, those that have been found in connection with severe infectious diseases. It is hardly conceivable that minute organisms which abound, for example, in the mouth, and give rise to no changes, should be capable in other parts of causing the most serious symptoms.

In order to prove that a micro-organism is the real cause of a disease, at least three conditions must be fulfilled: In the first place, the same species of micro-organism must be invariably found in the parts affected by the disease in question, at any rate during the early stage, and in no other affection. Secondly, the organism must be cultivated apart from the body in which it has been found, so as to make sure that it has been separated from all other morbid materials to the presence of which the disease might possibly be due. Thirdly, when the organisms thus cultivated have been introduced into the body of an animal capable of being attacked by the disease, similar symptoms ought to be set up, and the same micro-organisms should be found in the newly affected animal. If, in testing any given disease, these conditions are fulfilled, it is scarcely possible to doubt that the micro-organisms are the cause; they certainly can not be the result. It is fair also to argue from diseases in which the conditions are fulfilled, that others in which, owing to circumstances, the tests can not be properly carried out, are due to similar causes.

Very strong evidence is forthcoming in support of the theory that micro-organisms are the cause of infectious diseases. Horned cattle and sheep are subject to a disease termed *anthrax*, or splenic fever, and more than thirty years ago minute, rod-shaped bodies were found in the blood of animals which had died from this disease, which is also communicable to man. The significance of these rods was suspected only after Pasteur's researches into the part played by minute organisms in fermentation. Guided by these discoveries, Davaine inoculated healthy animals with blood from those diseased, with the result of producing similar symptoms, while myriads of organisms were found in the bodies of those animals which had been inoculated with a very minute quantity of blood. The symptoms are very characteristic, and the disease at one time caused an enormous mortality among cattle in France. By the opponents of the bacterium hypothesis it might, of course, be urged that in the inoculation experiments other morbid materials were simultaneously conveyed, and that the transmission of the disease was due to their presence. To meet this objection, and to fulfill the second condition laid down in the last paragraph, experiments for cultivating the organism were set on foot in the following manner: A drop of blood taken from an animal that had died from anthrax was put into a glass flask containing an infusion of yeast, which had been carefully treated and proved to be free from organisms. In twenty-four hours the liquid, previously clear, was seen to be full of very light flakes, which, when examined under the microscope, were found to be masses of organisms resembling those contained in the blood. A drop taken from this first flask was added to a second and produced the same effect, and a drop from this was added to a third, and so on till a tenth flask was thus charged with organisms. In this way the organism was enormously multiplied and completely freed from the admixture of any other substance. Yet when a drop was taken from the twentieth or even the fiftieth flask of such a series and inserted under the skin of a sheep it caused anthrax or splenic fever, attended by the same symptoms as those produced by the drop of blood taken from the first animal. It is impossible to conceive of any clearer proof that the organism is the sole cause of the disease. So crucial a test, however, can not be applied in every case, for many of the infectious diseases which are the scourge of mankind do not affect the lower animals, and it is therefore impossible to make trial of the organisms found in connection therewith. Besides anthrax, there are other infective diseases in animals which have been proved to be due to bacteria, and these facts strongly support the belief that the infectious diseases of mankind are due to the invasion of similar organisms. It is, however, impossible as yet to dogmatize upon this subject. There have already been too many assertions and inferences drawn therefrom which have turned out to be unwarranted. It is comparatively easy for skilled observers to detect the presence of micro-organisms, and, whenever uniformity of appearance is demonstrable in connection with a given disease, a decided addition has been made to our knowledge. For reasons above given, the next point, viz., the determining whether the organisms are the cause of the disease, is surrounded with great difficulties. The discoveries, however, with regard to splenic fever strongly support the view that bacteria are the efficient agents of contagious diseases.

Space will not permit me to do more than allude to the various theories that have been advanced with regard to the manner in which these tiny organisms produce disease. It was at first thought that they acted like parasites, and exhausted the system during their development. It is now, however, more commonly believed that the organisms elaborate a special ferment or poison, which, when produced in sufficient amount, gives rise to the symptoms of the disease.

One of the most valuable results of the study of these organisms is the discovery that by cultivation the virulence of some, at least, can be so mitigated that when inoculated they produce only slight and non-fatal symptoms, the development of which in a given animal is nevertheless protective against future attacks of the original disease. By cultivating the organisms of splenic fever at a temperature of 108°, it is found that filaments are produced but not spores, and that by repeated cultivation this growth becomes altered as regards its properties of causing disease. When inoculated it sets up a mild form of splenic fever, not dangerous to life, but perfectly protective against subsequent inoculation with the otherwise poisonous organisms. This discovery is worthy of being classed with that of vaccination as a protection against small-pox.

With regard to the channels through which the contagious organisms are spread, a few words will suffice to state what is known on this point, which is intimately connected with the subject of disinfection. Air and water are the chief media for the propagation of infectious disease. In the case of scarlet fever, which has been taken as the type, the scales detached from the skin and similar tissues from the throat contain the germs of the disease, and these find their way into the atmosphere and are received into the lungs. They attach themselves also to articles of clothing and furniture, and are thus often carried long distances. In the cases of cholera and typhoid fever, the discharges from the patient find their way into water, which thus becomes the channel by which the diseases are propagated. Food, too, may become similarly contaminated. Milk, for instance, has been often known to convey the poisons of typhoid fever, of scarlet fever, and of diphtheria. In the case of the first, the contamination has been probably due to adulterating the milk with foul water containing the disease-germs, but it may have arisen in some cases from the typhoid emanations having been absorbed by the milk. The poisons of scarlet fever and diphtheria were probably transmitted to the milk from the skins and throats of persons employed in the dairy and recently convalescent or scarcely recovered from attacks of these diseases. The germs of certain other infectious diseases find their way into the system through abraded surfaces of the body.

The fatal character of many infectious diseases, and the ease and rapidity with which they spread and attack large masses of the population, are sufficient to account for the endeavors that have been made since very early times to arrest their progress. As in many other matters, practice has preceded science, and, centuries before the vaguest ideas were entertained as to the nature of the diseases which seemed destined to be the scourges of mankind, efforts were made to stamp them out. As might be expected, many of these efforts were of the rudest description, but the earliest of them aimed at the object which the most modern science also seeks to achieve, viz., the destruction of the contagious material. The term "disinfection" first occurred in literature toward the end of the last century. A French writer, Morveau, in 1801, published a work on "The Disinfection of the Air," but the word was used somewhat earlier by a few English writers.

The most ancient method consisted in destroying by fire everything that had been in contact with the source of infection, the idea, no doubt, being that as fire consumes what is visible, it likewise destroys what is invisible. It is possible that the practice of burning the dead was in a measure based upon the conviction that a source of danger to the living was thus got rid of. The thirteenth chapter of Leviticus contains the most minute directions for disinfecting cases of leprosy; destruction of suspected articles by means of fire, the copious use of water, and isolation of the leper, are the means prescribed. Inspection by the priest was to decide as to the efficacy of these measures. Among the Egyptians and certain Asiatic peoples, the fumigations used by the priests in exorcising disease were probably neither more nor less efficacious than similar processes in vogue at the present day in some European countries.

In the growth of ideas with regard to the causes of infectious diseases, the theory gradually took shape that the infecting matters were formed as a result of the processes of decomposition, and as these processes are generally attended with the development of more or less unpleasant odors, it seemed only natural to assume that the causes of the latter were also the causes of disease. Instead of regarding foul emanations as generally mischievous, the idea was entertained that there was something quite specific about them, and accordingly we find that attempts to mask or neutralize them were regarded as the best methods of checking the spread of infectious diseases. Deodorization came to be considered as equivalent to disinfection. The idea was the more welcome inasmuch as it could be carried into effect without destroying property and without much difficulty. The attempt was certainly in the right direction, for the destruction of noxious agencies was the object in view. Unfortunately, the means employed absolutely failed to effect their purpose, and belief in their efficacy caused very mischievous results, viz., a sense of false security and neglect of ventilation and cleanliness as regards sick persons and surrounding objects. In fact, the confident adoption of deodorants as a means of checking the spread of infectious diseases was a decidedly retrograde step as compared with the use of fire for destruction and of water as a purifying agent.

Chlorine gas was the deodorant which came into very general use at the beginning of the present century. It was freely employed in hospitals, both civil and military, in prisons, workhouses, etc., and was supposed to be efficacious against fevers, cholera, and small-pox. Whenever its characteristic odor could be perceived, danger of infection was no longer feared. Persons carried about with them small flasks containing chemicals which generated this gas, and inhaled a little when they considered themselves exposed to risk. It soon, however, became evident that these precautions were useless; but even so recently as 1866, during the war between Austria and Prussia, it was thought sufficient to distribute saucers containing chloride of lime throughout the military hospitals, while only feeble efforts were made to insure cleanliness and other important sanitary requirements. In order to act as a real disinfectant, chlorine must be employed in a very different manner. The terrible mortality after surgical operations and severe injuries, a feature of which was that a large majority of patients died with symptoms of blood-poisoning, showed the futility of such attempts at disinfection.

In spite, however, of many similar failures, deodorization has been almost universally regarded as the main object to be accomplished, and other chemical agents have been used in order to combat the gaseous products of decomposition. This object could certainly be attained if the sense of smell were to be the sole judge of success, and the practice of deodorization led also to the discovery and use of many substances which have the power to prevent or retard putrefaction, and were therefore termed antiseptics, and regarded as equivalent to disinfectants. The conclusion, however, was soon forced upon the minds of experimenters that the infective agencies of fevers, small-pox, etc., were neither offensive gases nor the products of putrefaction, but something of an entirely different character. When an infectious disease became associated with the idea of a transportable material which increases and multiplies in its new ground, the discovery was not far off that organisms capable of reproduction are the real causes of the disease.

Definite ideas now prevail as to what is meant by disinfection, and as to the methods by which this object can be attained and the tests whereby their efficacy may be proved. Any substance may be regarded as a true disinfectant which, when added to a quantity of fluid swarming with bacteria, abolishes the reproductive power of these organisms. If the bacteria are capable of producing disease, or the poison of disease, a successful experiment has been made in the way of disinfection. This fact explains the paucity of the real experiences we possess of disinfection proper. Heat, exposure to air and sunlight, and the use of chemical agencies are the means at our disposal; it will be sufficient to point out a few of the methods in which they may be employed.

A very high temperature will, of course, destroy all forms of organized matter, and if we could always isolate the germs of disease and expose them to great heat, our task would be accomplished. Such isolation is of course impossible, but we make use of heat in the destruction of germs which have found a resting-place in clothes and bedding. The articles are placed in ovens or hot-air chambers, the temperature of which can be raised many degrees above the boiling-point of water. A high temperature, however, has less effect upon the spores than upon the mature organisms, but successive heatings are found to effect the desired result. During their development the spores rapidly pass through several stages, in which they become softened and far more amenable to the action of heat. Exposure to a current of steam at a temperature of 212° is a still more satisfactory method than the use of dry heat. It involves less injury to the articles to be disinfected (a very important point when blankets and other woolen goods have to be dealt with), and it is more simple, more rapid, and more certain in its action. When the necessary appliances are not available, washing the clothes with soap and hot water, and then boiling them for several hours, form an effective substitute. Exposure to sun and air will serve to complete the purification.

For the disinfection of the air of rooms many substances are recommended and employed, but the way in which they are generally used causes them to act merely as deodorants. Even at the present day, the fact is very incompletely realized that ventilation—that is, the continual admission of fresh air—is the only safe method of purifying the atmosphere of rooms containing sources of infection. It is simply useless to place saucers containing chloride of lime, carbolic acid, or Condy's fluid in a contaminated atmosphere with the hope that the germs floating about therein will be caught and killed, like mice in a trap. The chlorine, doubtless, will remove some offensive odors and readily diffuse itself throughout a room, but to act as a true disinfectant it must be so much concentrated that the air in the space containing it would be quite irrespirable by human beings. It is, however, when used scientifically, the best disinfectant we possess for purifying the walls, etc., of an empty room. All the openings should be rendered as nearly air-tight as possible, and the evaporation of a large quantity of water in the room aids the action of the chlorine. It is easily generated by adding hydrochloric acid to bleaching-powder. For deodorizing purposes in sick-rooms and passages, a gas called "euchlorine" will be found very serviceable. It is produced when a few crystals of chlorate of potassium are dropped into a little hydrochloric acid. The mixture can be conveniently made in a small wide-mouthed bottle, which should be placed as near the ceiling as possible, so that the gas may descend into the room. Chlorine and its compounds are much heavier than atmospheric air. Bromide is even more powerful as a disinfectant than chlorine, and both are far superior to sulphurous acid.

Carbolic acid has been much overrated as a disinfectant. The spores of the micro-organisms discovered in cases of splenic fever have been found to be absolutely unaffected after lying for upward of three months in a five-per-cent solution of carbolic acid in oil. It has been also found that vaccine matter mixed with carbolic acid in solution still retains its efficacy, and the question may therefore well be asked whether the highly diluted carbolic vapor used for purposes of aërial disinfection is not powerless to deal with an atmosphere saturated with the germs of infectious diseases.

When compelled to make use of water of a suspicious class, filtration and boiling constitute the most reliable methods of purification. Spongy iron is upon the whole the most efficacious filtering material. The water, especially if passed through sand afterward, comes out quite clear and pure, and may be kept for a long time without showing any signs of the production of living organisms. Charcoal filters, on the other hand, certainly sometimes allow spores or germs to pass through unchanged, and, when they are employed, boiling should always be superadded. It is not sufficient to bring the water once to the boiling-point ; in order to be efficacious, repeated boilings are necessary, for the reasons given in a preceding paragraph. Milk of a suspicious character should always be thus thoroughly boiled. Travelers on the Continent do well to provide themselves with small portable filters, now easily procurable, for in many places the drinking-water is highly charged with impurities. It is satisfactory to know than the tannin contained in tea is a purifying agent of some value as regards organic matter present in water.

It would take up too much space and would be foreign to the purpose I had in view to describe all the methods of using the various disinfectants which are now offered to the public. With regard to many of them it is sufficient to say that their power has been absurdly overestimated. It can not be too strongly insisted upon that deodorization is by no means equivalent to disinfection. My object has been to indicate in the first place what in the present state of our knowledge seems to be the true theory as to the causation of infectious diseases, and to show how obstacles are presented to more rapid scientific progress by the extreme minuteness of the organisms with which we have to deal. With regard to disinfection, I have striven to prove how entirely it must depend for its success on the specific action exercised upon the disease-germs by the means employed. The realization of this necessary relation can not fail to dispel many a fond belief with regard to disinfectants ; but it will leave us with a more intelligent and useful appreciation of their true properties, and, by revealing how far we still are from the goal of complete knowledge, may even stimulate the investigator to explore paths of science which are yet unknown. Virgil says, "Felix qui potuit rerum cognoscere causas," and to nothing is this aphorism nowadays more applicable than to a knowledge of those agencies which produce infectious diseases.—*Fortnightly Review.*

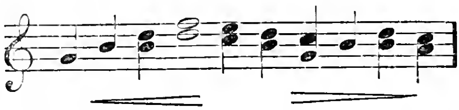
ON MELODY IN SPEECH.

By F. WEBER.

THERE is an infinite variety of interesting and pleasing sounds in Nature's music around us, that may be noted by an attentive ear; these sounds are mostly melodious and harmonious, or in some harmonious connection, and form exact intervals and chords.

The wind in passing over houses, over trees, in gardens, fields, and forests, produces beautiful sounds of every variety, swelling from the softest to the loudest in majestic grandeur. On a stormy morning in town I heard the wind sing this melody over the roof of the house:

and on a similar night at Boulogne I copied the following passage that was wailing through the house in beautiful *crescendo* and *decrescendo*, and in many repetitions:



Thunder strikes us with awe by its deep, rolling tones; a storm or gale* on land or on the ocean sends forth fierce and sublime sounds, rushing from the lowest to the highest pitch; the stately flow of a great river sings an everlasting deep organ-point, while the lively brook sings melodiously, and modulates like human speech.

The suspended wires of an electric telegraph, when vibrated by a strong wind, produce touching and wailing sounds and chords over a whole country, like so many Æolian harps of sweet and sad sounds that may, from solemn strains and most perfect ideal harmonies, rise in an indescribable and inimitable *crescendo*, higher and higher, to moans and discords, and with the abating wind return to harmony.

All the animals on land, quadrupeds and bipeds, have their characteristic voices and calls in distinct intervals. Of our domestic animals the cow gives a perfect fifth and octave or tenth:

* A *gale* in old Saxon and English means also a song, and with the bold sea-kings of old may also have had this meaning—a song on the ocean. *Gale* in Danish means to "crow": *Hanen galer*, the cock crows. Other relatives, the English to *call* and the German *Kehle*, throat, the organ of song.

The dog barks in a fifth or fourth :

The donkey in coarse voice brays in a perfect octave :

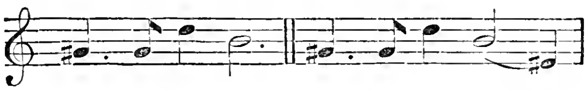
The horse neighs in a descent on the chromatic scale :

The cat in a meek mood cries :

when excited :

and at night on the roof in the garden may howl over an extended compass, and at times give cries like those of an infant.

The hens, geese and ducks in a farmyard chatter in pleasing chorus, and proud chanticleer crows piercing solos between, in the diminished triad and seventh chord :



The birds in bushes and trees, in gardens and woods, sing most beautiful tones in exact intervals, even in melodious chords and in measured time. In passing a garden in the southwest of London on a summer's afternoon, I noted the following tones of different birds in a few minutes :

Animals of the same species vary in their musical gift, as they do in other points. Some animals are very fond of music and greatly affected by it, while others are insensible or quite averse to it; of the former the horse has already in remote antiquity been mentioned for its joy at the sound of the trumpet, as we read in the book of Job (xxxix, 25). Shakespeare also says in his "Merchant of Venice":

> "For do but note a wild and wanton herd,
> Or race of youthful and unhandled colts,
> Fetching mad bounds, bellowing, and neighing loud,
> Which is the hot condition of their blood;
> If they but hear perchance a trumpet sound,
> Or any air of music touch their ears,
> You shall perceive them make a mutual stand,
> Their savage eyes turned to a modest gaze,
> By the sweet power of music."

A touching proof of this old truth was given in the late Franco-German War, when, in the evening after the battle of Gravelotte, on the trumpet-signal for the roll-call of the Life-Guards, more than three hundred riderless horses, some of them wounded and hobbling on three legs, answered the well-known sounds and mustered with the remnant of their regiment.

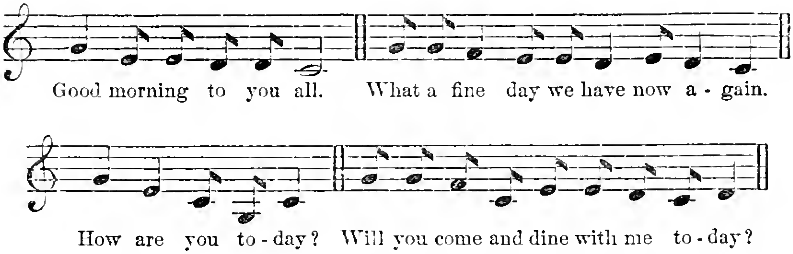
Of the nightingale it is said that in spring the males perch on a tree opposite the hens and sing their best one after another; whereupon the hens select their mates and fly off with them.

The intervals we observe most in the voices of animals are fifths, octaves, and thirds, and also fourths and sixths.

In inanimate sounding bodies, as in church-bells, in the larger strings of the piano, in the Æolian harp (or wind-harp), the fifth and tenth (or third in the next higher octave), commonly called *harmonics*, are very distinctly heard toward the end of the principal sound.

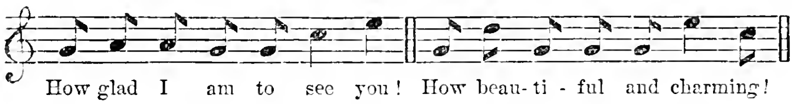
The *human voice* in speaking uses also these intervals foremost, but it moves also over most of the other intervals in melodious and harmonious combinations. We speak in melodies and harmonies, improvising them by the impulse of our thoughts and feelings over an extent or compass of one and a half to two octaves; as every plant grows with a certain color, so every sentence is spoken in some melody which rises in sympathy with the sense and sentiment of the words, giving character to the whole sentence; and from the quality and accent of this musical investment, the truth and sincerity of the words may be felt, and the character of the speaker be traced.

Sentences are spoken in a certain musical key, and are mostly begun on the fifth or dominant of the scale of the key-note, from which they descend in seconds or thirds or other intervals to the key-note, and, may be, down to the lower dominant:

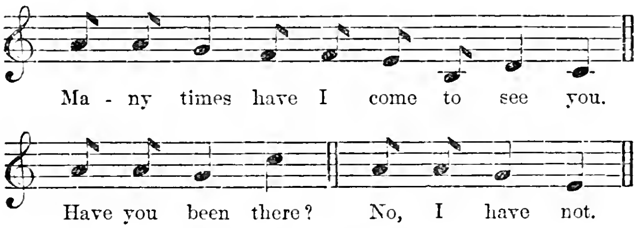


Or they begin on the key-note and move to the dominant :

Or they ascend from the dominant to the octave, and to the ninth and tenth :

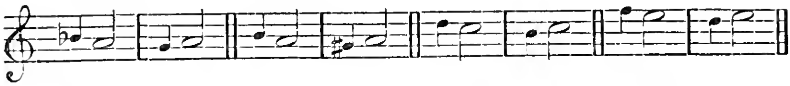


Many expressions are begun on the sixth as on a leading tone to the dominant :

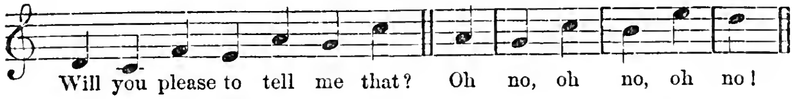


The voice moves mostly up and down in the principal scale and chord, and in their relative harmonies, and frequently dwells on introducing tones from above or below to a tone of any of these chords :

D minor. *A minor.*



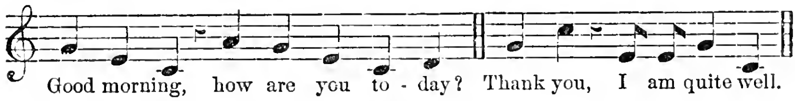
In C. *On the Dominant.*



In D minor.

In F.

Common conversation is generally held in the major mode, and in the same key:



But when sad and pathetic it is in minor:

An unfriendly reply is mostly in an unrelated key:

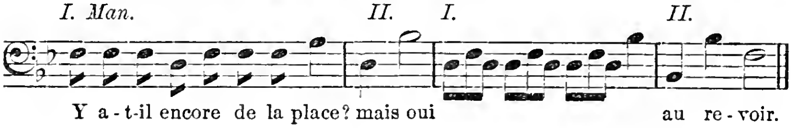
Every person has his own fundamental and favorite key in which he generally speaks, but which he often transposes higher or lower in sympathy to other voices, and when he is excited. In divine service at church I have heard the minister begin in his natural key, and the choir sing the response in a higher key; when the minister, possessing a musical ear, gradually rose to the tone of the choir. In one instance the minister began the communion service in E flat, and the choir and organ gave the response in F. The minister gradually raised his voice, and by the fourth commandment met the tone of the choir, wherein he continued to the end.

In ordinary conversation the different voices speak in the key of B flat, B, or C, persons with soprano or tenor voices moving in the upper part of the scale, and the alto and bass voices holding to the lower part of the same, and the replies turning often to the dominant or subdominant :

Conversation in a railway-train, of father, mother, and two daughters:

In a recent journey from Calais to Boulogne, Amiens, and Rheims, I found most people there speak in the key of B flat major and minor. The large bells at the belfry at Boulogne and at the cathedral at Rheims also have the low B flat, and may have been cast in that tone to be in unison with the voice of the people. Some of the conversations along the route, and the calling out of the names of railway-stations, were as follow:

Two women on Boulogne pier.

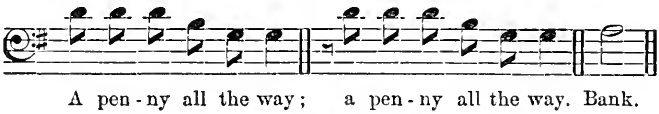


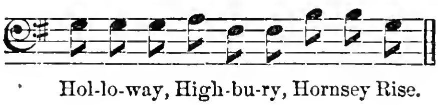
At the fish-market at Boulogne :

At Calais.

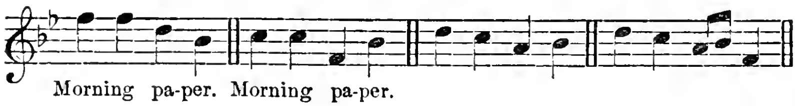
The French railway guards and conductors deserve to be complimented for their melodious calls of the names of the stations.

The omnibus conductors in London ordinarily call out in the key of B flat; but at busy places and hours they speak in a higher key. At Charing Cross I heard them call:





The paper boys call:



The calls of three paper boys I heard on one day at Charing Cross formed the dominant seventh chord: 

Some of the cries of venders in the streets are quite beautiful and touching, like the following I heard and noted down of a boy in Long Acre:

Slow.

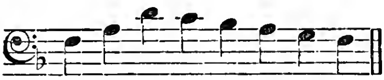
Of a man at Boulogne :

Slow.

A collection of such melodious and pleasant cries from towns in England and abroad would be most interesting in showing the musical talent and taste of the people who invent and use them.

Friendly conversations keep mostly to the key of the principal person of the circle, who at the time gives, not only the moral and social tone, but also the musical tone to all around him ; and if any one of the company would speak in a different tone, he would be out of tune and out of countenance with the others. When we read by ourselves we speak in C, or in B flat, or lower still ; but when we read to others, we raise our voice to the fourth or fifth of our own key, that is, to G, or F, or E flat.

We ought to study and exercise our voice in the different keys in which we may have to speak, through the whole extent of our voice, to enrich it with an easy flow of a variety of tones, so as to match our words and sentences with suitable melodious turns, to render them fervid and impressive, to touch a vibrating chord of sympathy and interest in our hearers.

When abroad I heard once a young orator speaking for nearly half an hour, with every sentence descending in these off tones of the scale  which unvarying descent of 6 5 4 3 2 1 made his well-worded speech tedious and unimpressive.

In a speech of some length the orator will save his voice by keeping more in the middle part of it, on and about his individual dominant, which part requires least strain and is the most pleasing ; from where he may with good effect rise or descend in accordance with the exciting or soothing flow of his ideas and sentiments. By thus arranging the melodious part of his speech somewhat like a musical composition, and suitably contrasting the high parts of his voice with the middle and lower parts, he will engage and rivet his audience all the more to every word.

Some persons spoil the sonorousness of their voice by not letting it flow out freely and naturally, by giving it a peculiar throaty twang, by speaking too high, or by using the head voice (falsetto) too much.

The natural voice, free from the chest, is most agreeable and effective in conversation and in addressing an audience; it is least fatiguing to the speaker and to the hearer, and penetrates farthest.

Spirited and impressive sermons, mostly in a major key, modulate in elevating ideas to the dominant, in soothing sentiments to the sub-dominant and the relative minor keys, but return and end in the principal key like a musical composition.

Collections of melodies in sermons and speeches of different nations would be most interesting and useful to students in oratory, be it for a dignified and becoming rendering of the great truths and sentiments in religion and humanity, or for persuasion, admonition, and encouragement in secular matters.

The following melodies I have copied from a speech by an Oxford professor, and from a sermon by an English bishop.

From an English speech (by an Oxford professor):

From (the sermon of an English bishop) an English sermon:

—*Longman's Magazine.*

PROFESSOR NEUMAYER, of Hamburg, urges the necessity of Antarctic exploration, laying special stress on its importance for geology and paleontology. He anticipates that it will show that the south pole was a center of dispersion of animals and plants for the southern hemisphere, as the north pole is believed to have been for the northern.

SCIENTIFIC AND PSEUDO-SCIENTIFIC REALISM.

BY PROFESSOR T. H. HUXLEY.

NEXT to undue precipitation in anticipating the results of pending investigations, the intellectual sin which is commonest and most hurtful to those who devote themselves to the increase of knowledge is the omission to profit by the experience of their predecessors recorded in the history of science and philosophy. It is true that, at the present day, there is more excuse than at any former time for such neglect. No small labor is needed to raise ones' self to the level of the acquisitions already made; and able men who have achieved thus much know that, if they devote themselves body and soul to the increase of their store, and avoid looking back with as much care as if the injunction laid on Lot and his family were binding upon them, such devotion is sure to be richly repaid by the joys of the discoverer and the solace of fame, if not by rewards of a less elevated character.

So, following the advice of Francis Bacon, we refuse *inter mortuos quærere vivum* (to seek what is living among the dead); we leave the past to bury its dead, and ignore our intellectual ancestry. Nor are we content with that. We follow the evil example set us, not only by Bacon, but by almost all the men of the Renaissance, in pouring scorn upon the work of our immediate spiritual forefathers, the school-men of the middle ages. It is accepted as a truth which is indisputable that, for seven or eight centuries, a long succession of able men—some of them of transcendent acuteness and encyclopedic knowledge—devoted laborious lives to the grave discussion of mere frivolities and the arduous pursuit of intellectual Will-o'-the-wisps. To say nothing of a little modesty, a little impartial pondering over personal experience might suggest a doubt as to the adequacy of this short and easy method of dealing with a large chapter of the history of the human mind. Even an acquaintance with popular literature which had extended so far as to include that part of the contributions of Sam Slick which contains his weighty aphorism that "there is a great deal of human nature in all mankind," might raise a doubt whether, after all, the men of that epoch, who, take them all round, were endowed with wisdom and folly in much the same proportion as ourselves, were likely to display nothing better than the qualities of energetic idiots, when they devoted their faculties to the elucidation of problems which were to them, and indeed are to us, the most serious which life has to offer. Speaking for myself, the longer I live the more I am disposed to think that there is much less either of pure folly or of pure wickedness in the world than is commonly supposed. It may be doubted if any sane man ever said to himself, "Evil, be thou my good," and I have never yet had the good fortune to meet with a perfect fool. When I have brought to the inquiry the patience and long-suffering which become a scientific investigator, the most promising specimens have turned out to have a good deal to say for themselves from their own point of view. And, sometimes, calm reflection has taught the humiliating lesson that their point of view was not so different from my own as I had fondly imagined. Comprehension is more than half-way to sympathy, here as elsewhere.

If we turn our attention to scholastic philosophy in the frame of mind suggested by these prefatory remarks, it assumes a very different character from that which it bears in general estimation. No doubt it is surrounded by a dense thicket of thorny logomachies and obscured by the dust-clouds of a barbarous and perplexing terminology. But suppose that, undeterred by much grime and by many scratches, the explorer has toiled through this jungle, he comes to an open country which is amazingly like his dear native land. The hills which he has to climb, the ravines he has to avoid, look very much the same; there is the same infinite space above, and the same abyss of the unknown below; the means of traveling are the same, and the goal is the same.

That goal for the school-men, as for us, is the settlement of the question how far the universe is the manifestation of a rational order; in other words, how far logical deduction from indisputable premises will account for that which has happened and does happen. That was the object of scholasticism, and, so far as I am aware, the object of modern science may be expressed in the same terms. In pursuit of this end, modern science takes into account all the phenomena of the universe which are brought to our knowledge by observation or by experiment. It admits that there are two worlds to be considered, the one physical and the other psychical, and that though there is a most intimate relation and interconnection between the two, the bridge from one to the other has yet to be found; that their phenomena run, not in one series, but along two parallel lines.

To the school-men the duality of the universe appeared under a different aspect. How this came about will not be intelligible unless we clearly apprehend the fact that they did really believe in dogmatic Christianity, as it was formulated by the Roman Church. They did not give a mere dull assent to anything the Church told them on Sundays, and ignore her teachings for the rest of the week; but they lived and moved and had their being in that supersensible theological world which was created, or rather grew up, during the first four centuries of our reckoning, and which occupied their thoughts far more than the sensible world in which their earthly lot was cast.

For the most part, we learn history from the colorless compendiums or partisan briefs of mere scholars, who have too little acquaintance with practical life, and too little insight into speculative problems, to understand that about which they write. In historical science, as in all sciences which have to do with concrete phenomena, laboratory practice is indispensable, and the laboratory practice of historical science is afforded, on the one hand, by active social and political life, and, on the other, by the study of those tendencies and operations of the mind which embody themselves in philosophical and theological systems. Thucydides and Tacitus, and, to come nearer our own time, Hume and Grote, were men of affairs, and had acquired, by direct contact with social and political history in the making, the secret of understanding how such history is made. Our notions of the intellectual history of the middle ages are, unfortunately, too often derived from writers who have never seriously grappled with philosophical and theological problems: and hence that strange myth of a millennium of moonshine to which I have adverted.

However, no very profound study of the works of contemporary writers who, without devoting themselves specially to theology or philosophy, were learned and enlightened—such men, for example, as Eginhard or Dante—is necessary to convince one's self that, for them, the world of the theologian was an ever-present and awful reality. From the center of that world, the Divine Trinity, surrounded by a hierarchy of angels and saints, contemplated and governed the insignificant sensible world in which the inferior spirits of men, burdened with the debasement of their material embodiment and continually solicited to their perdition by a no less numerous and almost as powerful hierarchy of devils, were constantly struggling on the edge of the pit of everlasting damnation.*

The men of the middle ages believed that through the Scriptures, the traditions of the fathers, and the authority of the Church, they

* There is no exaggeration in this brief and summary view of the Catholic cosmos. But it would be unfair to leave it be supposed that the Reformation made any essential alteration, except perhaps for the worse, in that cosmology which called itself "Christian." The protagonist of the Reformation, from whom the whole of the Evangelical sects are lineally descended, states the case with that plainness of speech, not to say brutality, which characterized him. Luther says that man is a beast of burden who only moves as his rider orders; sometimes God rides him, and sometimes Satan. "Sic voluntas humana in medio posita est, ceu jumentum; si insederit Deus, vult et vadit, quo vult Deus. . . . Si insederit Satan, vult et vadit, quo vult Satan; nec est in ejus arbitrio ad utrum sessorem currere, aut eum quærere, sed ipsi sessores certant ob ipsum obtinendum et possidendum" (Thus the human will is put in the middle, like a beast of burden; if God sits upon it, it wills and goes where God wills; . . . if Satan sits upon it, it wills and goes where Satan wills. Nor is it within its discretion to run to either rider or to seek after him, but the riders themselves contend which shall get and possess it).—(*De Servo Arbitrio*, M. Lutheri Opera, edition 1546, tomus ii, p. 468.) One may hear substantially the same doctrine preached in the parks and at street-corners by zealous volunteer missionaries of Evangelicism any Sunday in modern London. Why these doctrines, which are conspicuous by their absence in the four Gospels, should arrogate to themselves the title of Evangelical, in contradistinction to Catholic, Christianity, may well perplex the impartial inquirer, who, if he were obliged to choose between the two, might naturally prefer that which leaves the poor beast of burden a little freedom of choice.

were in possession of far more, and more trustworthy, information with respect to the nature and order of things in the theological world than they had in regard to the nature and order of things in the sensible world. And, if the two sources of information came into conflict, so much the worse for the sensible world, which, after all, was more or less under the dominion of Satan. Let us suppose that a telescope powerful enough to show us what is going on in the nebula of the sword of Orion, should reveal a world in which stones fell upward, parallel lines met, and the fourth dimensions of space was quite obvious. Men of science would have only two alternatives before them. Either the terrestrial and the nebular facts must be brought into harmony by such feats of subtile sophistry as the human mind is always capable of performing when driven into a corner, or Science must throw down its arms in despair, and commit suicide either by the admission that the universe is, after all, irrational, inasmuch as that which is truth in one corner of it is absurdity in another, or by a declaration of incompetency.

In the middle ages, the labors of those great men who endeavored to reconcile the system of thought which started from the data of pure reason with that which started from the data of Roman theology produced the system of thought which is known as scholastic philosophy; the alternative of surrender and suicide is exemplified by Avicenna and his followers when they declared that that which is true in theology may be false in philosophy, and *vice versa;* and by Sanchez in his famous defense of the thesis "*Quod nil scitur*" (That nothing is known).

To those who deny the validity of one of the primary assumptions of the disputants—who decline, on the ground of the utter insufficiency of the evidence, to put faith in the reality of that other world, the geography and the inhabitants of which are so confidently described in the so-called * Christianity of Catholicism—the long and bitter contest which engaged the best intellects for so many centuries may seem a terrible illustration of the wasteful way in which the struggle for existence is carried on in the world of thought, no less than in that of matter. But there is a more cheerful mode of looking at the history of scholasticism. It ground and sharpened the dialectic implements of our race as perhaps nothing but discussions, in the result of which men thought their eternal no less than their temporal interests were at stake, could have done. When a logical blunder may insure combustion, not only in the next world but in this, the construction of syllogisms acquires a peculiar interest. Moreover, the schools kept the thinking faculty alive and active, when the disturbed state of civil life, the mephitic atmosphere engendered by the dominant ecclesiasticism, and

* I say "so-called," not by way of offense, but as a protest against the monstrous assumption that Catholic Christianity is explicitly or implicitly contained in any trustworthy record of the teaching of Jesus of Nazareth.

the almost total neglect of natural knowledge, might well have stifled it. And, finally, it should be remembered that scholasticism really did thrash out pretty effectually certain problems which have presented themselves to mankind ever since they began to think, and which, I suppose, will present themselves so long as they continue to think. Consider, for example, the controversy of the Realists and the Nominalists, which was carried on with varying fortunes, and under various names, from the time of Scotus Erigena to the end of the scholastic period. Has it now a merely antiquarian interest? Has Nominalism, in any of its modifications, so completely won the day that Realism may be regarded as dead and buried without hope of resurrection? Many people seem to think so, but it appears to me that, without taking Catholic philosophy into consideration, one has not to look about far to find evidence that Realism is still to the fore, and indeed extremely lively.*

The other day I happened to meet with a report of a sermon recently preached in St. Paul's Cathedral. From internal evidence I am inclined to think that the report is substantially correct. But, as I have not the slightest intention of finding fault with the eminent theologian and eloquent preacher to whom the discourse is attributed, for employment of scientific language in a manner for which he could find only too many scientific precedents, the accuracy of the report in detail is not to the purpose. I may safely take it as the embodiment of views which are thought to be quite in accordance with science by many excellent, instructed, and intelligent people:

> The preacher further contended that it was yet more difficult to realize that our earthly home would become the scene of a vast physical catastrophe. Imagination recoils from the idea that the course of Nature—the phrase helps to disguise the truth—so unvarying and regular, the ordered sequence of movement and life, should suddenly cease. Imagination looks more reasonable when it assumes the air of scientific reason. Physical law, it says, will prevent the occurrence of catastrophes only anticipated by an apostle in an unscientific age. Might not there, however, be a suspension of a lower law by the intervention of a higher? Thus, every time we lifted our arms we defied the laws of gravitation, and in railways and steamboats powerful laws were held in check by others. The Flood and the destruction of Sodom and Gomorrah were brought about by the operations of existing laws, and may it not be that in His illimitable universe there are more important laws than those which surround our puny life—moral and not merely physical forces? Is it inconceivable that the day will

* It may be desirable to observe that, in modern times, the term "Realism" has acquired a signification wholly different from that which attached to it in the middle ages. We commonly use it as the contrary of Idealism. The Idealist holds that the phenomenal world has only a subjective existence, the Realist that it has an objective existence. I am not aware that any mediæval philosopher was an Idealist in the sense in which we apply the term to Berkeley. In fact, the cardinal defect of their speculations lies in their oversight of the considerations which lead to Idealism. If many of them regarded the material world as a negation, it was an active negation; not zero, but a minus quantity.

come when these royal and ultimate laws shall wreck the natural order of things which seems so stable and so fair? Earthquakes were not things of remote antiquity, as an island off Italy, the Eastern Archipelago, Greece, and Charleston bore witness. . . . In presence of a great earthquake men feel how powerless they are, and their very knowledge adds to their weakness. The end of human probation, the final dissolution of organized society, and the destruction of man's home on the surface of the globe, were none of them violently contrary to our present experience, but only the extension of present facts. The presentiment of death was common; there were felt to be many things which threatened the existence of society; and, as our globe was a ball of fire, at any moment the pent-up forces which surge and boil beneath our feet might be poured out.—*Pall Mall Gazette, December* 6, 1886.

The preacher appears to entertain the notion that the occurrence of a "catastrophe" * involves a breach of the present order of Nature—that it is an event incompatible with the physical laws which at present obtain. He seems to be of opinion that "scientific reason" lends its authority to the imaginative supposition that physical law will prevent the occurrence of the "catastrophes" anticipated by an unscientific apostle.

Scientific reason, like Homer, sometimes nods; but I am not aware that it has ever dreamed dreams of this sort. The fundamental axiom of scientific thought is that there is not, never has been, and never will be, any disorder in Nature. The admission of the occurrence of any event which was not the logical consequence of the immediately antecedent events, according to these definite ascertained, or unascertained, rules which we call the "laws of Nature," would be an act of self-destruction on the part of Science.

"Catastrophe" is a relative conception. For ourselves it means an event which brings about very terrible consequences to man, or impresses his mind by its magnitude relatively to him. But events which are quite in the natural order of things to us, may be frightful catastrophes to other sentient beings. Surely no interruption of the order of Nature is involved if, in the course of descending through an Alpine pine-wood, I jump upon an ant-hill and in a moment wreck a whole city and destroy a hundred thousand of its inhabitants. To the ants, the catastrophe is worse than the earthquake of Lisbon. To me, it is the natural and necessary consequence of the laws of matter in motion. A redistribution of energy has taken place, which is perfectly in accordance with natural order, however unpleasant its effects may be to the ants.

Imagination, inspired by scientific reason, and not merely assuming the airs thereof, as it unfortunately too often does in the pulpit, so far from having any right to repudiate catastrophes and deny the possi-

* At any rate, a catastrophe greater than the Flood, which, as I observe with interest, is as calmly assumed by the preacher to be an historical event as if Science had never had a word to say on that subject!

bility of the cessation of motion and life, easily finds justification for the exactly contrary course. Kant, in his famous "Theory of the Heavens," declares the end of the world and its reduction to a formless condition to be a necessary consequence of the causes to which it owes its origin and continuance. And, as to catastrophes of prodigious magnitude and frequent occurrence, they were the favorite *asylum ignorantiæ* (asylum of ignorance) of geologists not a quarter of a century ago. If modern geology is becoming more and more disinclined to call in catastrophes to its aid, it is not because of any *a priori* difficulty in reconciling the occurrence of such events with the universality of order, but because the *a posteriori* evidence of the occurrence of events of this character in past times has more or less completely broken down.

It is, to say the least, highly probable that this earth is a mass of extremely hot matter, invested by a cooled crust, through which the hot interior still continues to cool, though with extreme slowness. It is no less probable that the faults and dislocations, the foldings and fractures, everywhere visible in the stratified crust, its large and slow movements through miles of elevation and depression, and its small and rapid movements which give rise to the innumerable perceived and unperceived earthquakes which are constantly occurring, are due to the shrinkage of the crust on its cooling and contracting nucleus.

Without going beyond the range of fair scientific analogy, conditions are easily conceivable which should render the loss of heat far more rapid than it is at present; and such an occurrence would be just as much in accordance with ascertained laws of Nature as the more rapid cooling of a red-hot bar, when it is thrust into cold water, than when it remains in the air. But much more rapid cooling might entail a shifting and rearrangement of the parts of the crust of the earth on a scale of unprecedented magnitude, and bring about "catastrophes" to which the earthquake of Lisbon is but a trifle. It is conceivable that man and his works and all the higher forms of animal life should be utterly destroyed; that mountain-regions should be converted into ocean-depths and the floor of oceans raised into mountains; and the earth become a scene of horror which even the lurid fancy of the writer of the Apocalypse would fail to portray. And yet, to the eye of Science, there would be no more disorder here than in the sabbatical peace of a summer sea. Not a link in the chain of natural causes and effects would be broken, nowhere would there be the slightest indication of the "suspension of a lower law by a higher." If a sober scientific thinker is inclined to put little faith in the wild vaticinations of universal ruin which, in a less saintly person than the seer of Patmos, might seem to be dictated by the fury of a revengeful fanatic, rather than by the spirit of Him who bid men love their enemies, it is not on the ground that they contradict scientific principles, but because the evidence of their scientific value does not fulfill the conditions on which weight is attached to evidence. The imagination which supposes that it does, simply does not "assume the air of scientific reason."

I repeat that, if imagination is used within the limits laid down by science, disorder is unimaginable. If a being endowed with perfect intellectual and æsthetic faculties, but devoid of the capacity for suffering pain, either physical or moral, were to devote his utmost powers to the investigation of Nature, the universe would seem to him to be a sort of kaleidoscope, in which, at every successive moment of time, a new arrangement of parts of exquisite beauty and symmetry would present itself; and each of them would show itself to be the logical consequence of the preceding arrangement, under the conditions which we call the laws of Nature. Such a spectator might well be filled with that *Amor intellectualis Dei* (intellectual love of God), the beatific vision of the *vita contemplativa* (contemplative life), which some of the greatest thinkers of all ages, Aristotle, Aquinas, Spinoza, have regarded as the only conceivable eternal felicity; and the vision of illimitable suffering, as if sensitive beings were unregarded animalcules which had got between the bits of glass of the kaleidoscope, which mars the prospect to us poor mortals, in no wise alters the fact that order is lord of all, and disorder only a name for that part of the order which gives us pain.

The other fallacious employment of the names of scientific conceptions which pervades the preacher's utterance, brings me back to the proper topic of the present paper. It is the use of the word "law" as if it denoted a thing—as if a "law of Nature," as Science understands it, were a being endowed with certain powers, in virtue of which the phenomena expressed by that law are brought about. The preacher asks, "Might not there be a suspension of a lower law by the intervention of a higher?" He tells us that every time we lift our arms we defy the law of gravitation. He asks whether some day certain "royal and ultimate laws" may not come and "wreck" those laws which are at present, it would appear, acting as Nature's police. It is evident, from these expressions, that "laws," in the mind of the preacher, are entities having an objective existence in a graduated hierarchy. And it would appear that the "royal laws" are by no means to be regarded as constitutional royalties: at any moment, they may, like Eastern despots, descend in wrath among the middle-class and plebeian laws, which have hitherto done the drudgery of the world's work, and—to use phraseology not unknown in our seats of learning—"make hay" of their belongings. Or perhaps a still more familiar analogy has suggested this singular theory; and it is thought that high laws may "suspend" low laws, as a bishop may suspend a curate.

Far be it from me to controvert these views, if any one likes to hold them. All I wish to remark is that such a conception of the nature of "laws" has nothing to do with modern science. It is scholastic realism—realism as intense and unmitigated as that of Scotus Erigena a thousand years ago. The essence of such realism is that it maintains the objective existence of universals, or, as we call them nowadays, general propositions. It affirms, for example, that "man" is a real thing, apart from individual men, having its existence, not in the sensible but in the intelligible world, and clothing itself with the accidents of sense to make the Jack and Tom and Harry whom we know. Strange as such a notion may appear to modern scientific thought, it really pervades ordinary language. There are few people who would, at once, hesitate to admit that color, for example, exists apart from the mind which conceives the idea of color. They hold it to be something which resides in the colored object; and so far they are as much realists as if they had sat at Plato's feet. Reflection on the facts of the case must, I imagine, convince every one that "color" is—not a mere name, which was the extreme Nominalist position—but a name for that group of states of feeling which we call blue, red, yellow, and so on, and which we believe to be caused by luminiferous vibrations which have not the slightest resemblance to color; while these, again, are set afoot by states of the body to which we ascribe color, but which are equally devoid of likeness to color.

In the same way, a law of Nature, in the scientific sense, is the product of a mental operation upon the facts of Nature which come under our observation, and has no more existence outside the mind than color has. The law of gravitation is a statement of the manner in which experience shows that bodies, which are free to move, do, in fact, move toward another. But the other facts of observation, that bodies are not always moving in this fashion, and sometimes move in a contrary direction, are implied in the words "free to move." If it is a law of Nature that bodies tend to move toward one another in a certain way, it is another and no less true law of Nature that, if bodies are not free to move as they tend to do, either in consequence of an obstacle or of a contrary impulse from some other source of energy than that to which we give the name of gravitation, they either stop still or go another way.

Scientifically speaking, it is the acme of absurdity to talk of a man defying the law of gravitation when he lifts his arm. The general store of energy in the universe working through terrestrial matter is doubtless tending to bring the man's arm down; but the particular fraction of that energy which is working through certain of his nervous and muscular organs is tending to drive it up, and, more energy being expended on the arm in the upward than in the downward direction, the arm goes up accordingly. But the law of gravitation is no more defied in this case than when a grocer throws so much sugar into the empty pan of his scales that the weighted one kicks the beam.

The tenacity of the wonderful fallacy that the laws of Nature are agents instead of being, as they really are, a mere record of experience, upon which we base our interpretations of that which does happen, and our anticipation of that which will happen, is an interesting psychological fact, and would be unintelligible if the tendency of the human mind toward realism were less strong.

Even at the present day, and in the writings of men who would at once repudiate scholastic realism in any form, "law" is often inadvertently employed in the sense of cause, just as, in common life, a man will say that he is compelled by the law to do so and so, when, in point of fact, all he means is that the law orders him to do it, and tells him what will happen if he does not do it. We commonly hear of bodies falling to the ground by reason of the law of gravitation, whereas that law is simply the record of the fact that, according to all experience, they have so fallen (when free to move), and of the grounds of a reasonable expectation that they will so fall. If it should be worth anybody's while to seek for examples of such misuse of language on my own part, I am not at all sure he might not succeed, though I have usually been on my guard against such looseness of expression. If I am guilty, I do penance beforehand, and only hope that I may thereby deter others from committing the like fault. And I venture on this personal observation by way of showing that I have no wish to bear hardly on the preacher for falling into an error for which he might find good precedents. But it is one of those errors which, in the case of a person engaged in scientific pursuits, does little harm, because it is corrected as soon as its consequences become obvious; while those who know physical science only by name are, as has been seen, easily led to build a mighty fabric of unrealities on this fundamental fallacy. In fact, the habitual use of the word "law," in the sense of an active thing, is almost a mark of pseudo-science; it characterizes the writings of those who have appropriated the forms of science without knowing anything of its substance.

There are two classes of these people: those who are ready to believe in any miracle so long as it is guaranteed by ecclesiastical authority, and those who are ready to believe in any miracle so long as it has some different guarantee. The believers in what are ordinarily called miracles—those who accept the miraculous narratives which they are taught to think are essential elements of religious doctrine—are in the one category; the spirit-rappers, table-turners, and all the other devotees of the occult sciences of our day are in the other; and, if they disagree in most things, they agree in this, namely, that they ascribe to science a dictum that is not scientific; and that they endeavor to upset the dictum thus foisted on science by a realistic argument which is equally unscientific.

It is asserted, for example, that, on a particular occasion, water was turned into wine; and, on the other hand, it is asserted that a man or a woman "levitated" to the ceiling, floated about there, and finally sailed out by the window. And it is assumed that the pardonable skepticism, with which most scientific men receive these statements, is due to the fact that they feel themselves justified in denying the possibility of any such metamorphosis of water or of any such levitation, because such events are contrary to the laws of Nature. So the question of the preacher is triumphantly put: How do you know that there are not "higher" laws of Nature than your chemical and physical laws, and that these higher laws may not intervene and "wreck" the latter?

The plain answer to this question is, Why should anybody be called upon to say how he knows that which he does not know? You are assuming that laws are agents—efficient causes of that which happens—and that one law can interfere with another. To us that assumption is as nonsensical as if you were to talk of a proposition of Euclid being the cause of the diagram which illustrates it, or of the integral calculus interfering with the rule of three. Your question really implies that we pretend to complete knowledge not only of all past and present phenomena, but of all that are possible in the future, and we leave all that sort of thing to the adepts of esoteric Buddhism. Our pretensions are infinitely more modest. We have succeeded in finding out the rules of action of a little bit of the universe; we call these rules "laws of Nature," not because anybody knows whether they bind Nature or not, but because we find it is obligatory on us to take them into account, both as actors under Nature, and as interpreters of Nature. We have any quantity of genuine miracles of our own, and, if you will furnish us with as good evidence of your miracles as we have of ours, we shall be quite happy to accept them and to amend our expression of the laws of Nature in accordance with the new facts.

As to the particular cases adduced, we are so perfectly fair-minded as to be willing to help your case as far as we can. You are quite mistaken in supposing that anybody who is acquainted with the possibilities of physical science will undertake categorically to deny that water may be turned into wine. Many very competent judges are already inclined to think that the bodies, which we have hitherto called elementary, are really composite arrangements of the particles of a uniform primitive matter. Supposing that view to be correct, there would be no more theoretical difficulty about turning water into alcohol, ethereal and coloring matters, than there is at this present moment any practical difficulty in working other such miracles; as when we turn sugar into alcohol, carbonic acid, glycerine, and succinic acid; or transmute gas-refuse into perfumes rarer than musk, and dyes richer than Tyrian purple. If the so-called "elements," oxygen and hydrogen, which compose water, are aggregates of the same ultimate particles or physical units, as those which enter into the structure of the so-called element "carbon," it is obvious that alcohol and other substances—composed of carbon, hydrogen, and oxygen—may be produced by a rearrangement of some of the units of oxygen and hydrogen into the "element" carbon, and their synthesis with the rest of the oxygen and hydrogen.

Theoretically, therefore, we can have no sort of objection to your miracle. And our reply to the levitators is just the same: Why should not your friend "levitate"? Fish are said to rise and sink in the water by altering the volume of an internal air-receptacle, and there may be many ways Science, as yet, knows nothing of, by which we who live at the bottom of an ocean of air may do the same thing. Dialectic gas and wind appear to be by no means wanting among you, and why should not long practice in pneumatic philosophy have resulted in the internal generation of something a thousand times rarer than hydrogen, by which, in accordance with the most ordinary natural laws, you would not only rise to the ceiling and float there in *quasi*-angelic posture, but perhaps, as one of your feminine adepts is said to have done, flit swifter than train or telegram to "still-vexed Bermoothes," and twit Ariel, if he happens to be there, for a sluggard? We have not the presumption to deny the possibility of anything you affirm—only, as our brethren are particular about evidence, do give us as much to go upon as may save us from being roared down by their inextinguishable laughter.

Enough of the realism which clings about "laws." There are plenty of other exemplifications of its vitality in modern science, but I will cite only one of them.

This is the conception of "vital force" which comes straight from the philosophy of Aristotle. It is a fundamental proposition of that philosophy that a natural object is composed of two constituents—the one its matter, conceived as inert or even, to a certain extent, opposed to orderly and purposive motion; the other its form, conceived as a *quasi*-spiritual something, containing or conditioning the actual activities of the body and the potentiality of its possible activities.

I am disposed to think that the prominence of this conception in Aristotle's theory of things arose from the circumstance that he was, to begin with and throughout his life, devoted to biological studies. In fact, it is a notion which must force itself upon the mind of any one who studies biological phenomena, without reference to general physics as they now stand. Everybody who observes the obvious phenomena of the development of a seed into a tree, or of an egg into an animal, will note that a relatively formless mass of matter gradually grows, takes a definite shape and structure, and finally begins to perform actions which contribute toward a certain end, namely, the maintenance of the individual in the first place, and of the species in the second. Starting from the axiom that every event has a cause, we have here the *causa finalis* (final cause) manifested in the last set of phenomena, the *causa materialis* (material cause) and *formalis* (formal) in the first, while the existence of a *causa efficiens* (efficient cause) within the seed or egg and its product, is a corollary from the phenomena of growth and metamorphosis, which proceed in unbroken succession and make up the life of the animal or plant.

Thus, at starting, the egg or seed is matter having a "form" like all other material bodies. But this form has the peculiarity, in contradistinction to lower substantial "forms," that it is a power which constantly works toward an end by means of living organization.

So far as I know, Liebnitz is the only philosopher (at the same time a man of science, in the modern sense, of the first rank) who has noted that the modern conception of Force, as a sort of atmosphere enveloping the particles of bodies, and having potential or actual activity, is simply a new name for the Aristotelian Form.* In modern biology, up till within quite recent times, the Aristotelian conception held undisputed sway; living matter was endowed with "vital force," and that accounted for everything. Whosoever was not satisfied with that explanation was treated to that very "plain argument"—"confound you eternally"—wherewith Lord Peter overcomes the doubts of his brothers in the "Tale of a Tub." "Materialist" was the mildest term applied to him—fortunate if he escaped pelting with "infidel" and "atheist." There may be scientific Rip Van Winkles about, who still hold by vital force; but among those biologists who have not been asleep for the last quarter of a century "vital force" no longer figures in the vocabulary of science. It is a patent survival of realism; the generalization from experience that all living bodies exhibit certain activities of a definite character is made the basis of the notion that every living body contains an entity, "vital force," which is assumed to be the cause of those activities.

It is remarkable, in looking back, to notice to what an extent this and other survivals of scholastic realism arrested or, at any rate, impeded the application of sound scientific principles to the investigation of biological phenomena. When I was beginning to think about these matters, the scientific world was occasionally agitated by discussions respecting the nature of the "species" and "genera" of naturalists, of a different order from the disputes of a later time. I think most were agreed that a "species" was something which existed objectively, somehow or other, and had been created by a Divine fiat. As to the objective reality of genera, there was a good deal of difference of opinion. On the other hand, there were a few who could see no objective reality in anything but individuals, and looked upon both species and genera as hypostatized universals. As for myself, I seem to have unconsciously emulated William of Occam, inasmuch as almost the first public discourse I ever ventured upon dealt with "Animal Individuality," and its tendency was to fight the Nominalist battle even in that quarter.

* "Les formes des anciens ou entéléchies ne sont autre chose que les forces" (The forms of the ancients, or entelechciæ, are nothing else than forces).—(Leibnitz, "Lettre au Père Bouvet," 1697.)

Realism appeared in still stranger forms at the time to which I refer. The community of plan which is observable in each great group of animals was hypostatized into a Platonic idea with the appropriate name of "archetype," and we were told, as a disciple of Philo-Judæus might have told us, that this realistic figment was "the archetypal light" by which Nature has been guided amid the "wreck of worlds." So, again, another naturalist who had no less earned a well-deserved reputation by his contributions to positive knowledge, put forward a theory of the production of living things which, as nearly as the increase of knowledge allowed, was a reproduction of the doctrine inculcated by the Jewish Cabala.

Annexing the archetype notion, and carrying it to its full logical consequence, the author of this theory conceived that the species of animals and plants were so many incarnations of the thoughts of God—material representations of Divine Ideas during the particular period of the world's history at which they existed. But, under the influence of the embryological and paleontological discoveries of modern times, which had already lent some scientific support to the revived ancient theories of cosmical evolution or emanation, the ingenious author of this speculation, while denying and repudiating the ordinary theory of evolution by successive modification of individuals, maintained and endeavored to prove the occurrence of a progressive modification in the Divine Ideas of successive epochs.

On the foundation of a supposed elevation of organization in the whole living population of any epoch as compared with that of its predecessor, and a supposed complete difference in species between the populations of any two epochs (neither of which suppositions has stood the test of further inquiry), the author of this speculation based his conclusion that the Creator had, so to speak, improved upon his thoughts as time went on; and that, as each such amended scheme of creation came up, the embodiment of the earlier divine thoughts was swept away by a universal catastrophe, and an incarnation of the improved ideas took its place. Only after the last such "wreck" thus brought about did the embodiment of a divine thought, in the shape of the first man, make its appearance as the *ne plus ultra* of the cosmogonical process.

I imagine that Louis Agassiz, the genial backwoodsman of the science of my young days, who did more to open out new tracks in the scientific forest than most men, would have been much surprised to learn that he was preaching the doctrine of the Cabala, pure and simple. According to this modification of Neoplatonism by contact with Hebrew speculation, the divine essence is unknowable—without form or attribute; but the interval between it and the world of sense is filled by intelligible entities, which are nothing but the familiar hypostatized abstractions of the realists. These have emanated, like immense waves of light, from the divine center, and, as ten consecutive zones of Sephiroth, form the universe. The farther away from the center, the more the primitive light wanes, until the periphery ends in those mere negations, darkness and evil, which are the essence of matter. On this, the divine agency transmitted through the Sephiroth operates after the fashion of the Aristotelian forms and, at first, produces the lowest of a series of worlds. After a certain duration the primitive world is demolished and its fragments used up in making a better; and this process is repeated, until at length a final world, with man for its crown and finish, makes its appearance. It is needless to trace the process of retrogressive metamorphosis by which, through the agency of the Messiah, the steps of the process of evolution here sketched are retraced. Sufficient has been said to prove that the extremest realism current in the philosophy of the thirteenth century can be fully matched by the speculations of our own time.—*Nineteenth Century.*

BIRD-MIGRATION.

By BARTON W. EVERMANN.

NINE hundred and forty-one species and sub-species of birds are now recognized by ornithologists as belonging to the avi-fauna of North America. Eighty-two of these may be regarded as stragglers from other countries, and their occurrence in North America as purely accidental. Of these eighty-two species, about twenty-two have been found in Greenland, fourteen in Alaska, fourteen in Florida, thirteen in Texas, and the remaining ones, about a score, in various other parts of the United States—only one or two in any one place, however. We thus have left about eight hundred and fifty-nine species, of which this continent may properly be called the habitat.

About two hundred of these have been identified as birds of the county* in which the writer lives. Twenty-six species of these two hundred are permanently resident here—that is, they rear their young here, and they or other individuals of their species remain with us throughout the year. Fourteen other species visit us from the North, and only in the winter. Besides the twenty-six permanent residents, about seventy-five other species breed within our borders, while the remaining eighty-five species are seen here only for a few days in spring, and again for a short time in the fall. Twice a year they flit by us like an apparition, and we ask: Whence come these birds in spring; where do they spend the summer; and whither do they go when winter comes? Since life of bird and man began, these questions have been asked and studied, but not always have the results been satisfactory.

* Monroe County, Indiana.

It had long been observed that, as the sun comes to our side of the equator, the buds swell, the leaves and flowers unfold, and a sheet of verdure expands and spreads toward the pole; and closely following this there comes a mighty army of bird-life—orioles, tanagers, and warblers of brightest hue—filling every orchard, grove, and woodland with life, and song, and joy. And again, when autumn comes, the wave returns to us from the North, bringing with it the black snow-birds and other species which make their winter home with us, while the great bulk of the species pass on to the southward as mysteriously as they came.

The flight of storks has given trouble to the Germans and the Chinese, while the disappearance and the reappearance of the swallows have caused untold trouble everywhere. Learned bodies, like the French Academy and the Royal Society of London, have gravely asserted that, in the fall, swallows plunge into the mud of marshes and mill-ponds, become torpid, and hibernate like frogs and snakes. I have seen a list of nearly two hundred articles written all along from the middle of the seventeenth century down to 1877, for the purpose of proving or disproving the hibernation of swallows and other birds! And Dr. Coues says he can lay his hand upon papers of that period which discuss the migration of swallows to the moon, the falling of the little quadrupeds called lemmings in showers from the clouds, and the origin of brant-geese from barnacles that grew on trees. Indeed, not a year ago I was assured by a gentleman of more than average intelligence that this last is undoubtedly the correct theory as to the origin of the barnacle-goose! And it was not a decade ago that I read, in one of the leading newspapers of this State, an article of as curious a character. Its purpose was to explain the sudden appearance in fall of the black snow-birds, and their as sudden disappearance in spring, and the explanation given was that our common sparrows change color in fall, becoming snow-birds, which they remain until spring, when they put on their other dress and become sparrows again! And I find that, among the common people of the country, there are many who have this belief.

We have long known in a general way that the birds go southward to winter, and return to spend the summer at the North. But just where in the South do they go? Why do they go there? By what routes do they travel? At what rate of speed? Do they travel by night, or day, or both? What species migrate first, which last, and why? How are they guided in their course? What is the winter as well as the summer habitat of each particular species, when does it get there, and when does it leave the one for the other? In what way and to what extent are their movements dependent upon or influenced by vegetable and meteorological phenomena?

These are but a few of the questions which ornithologists have sought in various ways to answer. The limits of this paper will permit any discussion of but few of these interesting questions. From their very nature it is evident that futile must prove the labors of him who would attempt to solve these problems alone. Only through the concerted action and labors of many observers in different and widely separated regions can any reliable conclusions be reached. Not until recently has the subject of bird-migration been studied systematically in this country or elsewhere.

Three years ago a gentleman* in the Mississippi Valley addressed personal letters to several hundred naturalists, teachers, ministers, farmers, and others in the different Valley States, asking them to co-operate with him in studying the movements of the birds of this region. They were requested to note only the more common phenomena of migration, such as the time of arrival and departure of each species, the time of breeding, and the comparative abundance of the various species. They were asked to record such observations as they could, and send in reports to him of what they had seen. More than one hundred observers were thus secured, who reported to him the results of their observations, and this, if I mistake not, was the first corps of migration observers in America.

A little later, in September, 1883, the American Ornithologists' Union was organized. Among the committees appointed at its first meeting was one on "The Migration and Geographical Distribution of North American Birds." Dr. C. Hart Merriam, of Locust Grove, New York, was made chairman of this committee. It has been and is the purpose of this committee "to investigate in all its bearings, and to the fullest extent possible, the subject of the migration of birds in the United States and British North America. Its work is not limited to the accumulation of records of the time of arrival and departure of the different species, but it embraces as well the collection of all data that may aid in determining the causes which influence the progress of migration from season to season." For example, severe storms, gales of wind, long periods of unusally high or low temperature, are some of the atmospheric conditions which are known to exert marked effects upon the movements of birds.

In order to secure as many observers as possible, and that the material collected by this great army of observers be speedily elaborated, the United States was divided into a dozen or more districts, each of which was placed in charge of a competent superintendent. The superintendent's duties are to secure as many observers in his district as he can, to give them all needed instructions concerning the work, to act as a means of communication between the observers and the chairman of the committee, to collect, at stated times, the results of their observations, and submit them to the committee. The chairman will arrange, condense, and systematize these reports, and present

* Professor W. W. Cooke, then of Jefferson, Wisconsin, now of Burlington, Vermont.

to the Union the fruits of the joint labors of this great corps of observers, together with such deductions or generalizations as he may be able to base upon them.

By noting the species which are permanent residents, which winter residents or visitants, which summer residents, and which spring and fall migrants, together with the relative abundance of each species in each locality where found, the geographical distribution of our birds has already been pretty well made out.

A like series of observations upon the time of arrival and departure of each species, the manner of its coming and going, the period of its stay, the place and time of its nesting, enables us to learn much of its life-history. And a study of meteorological phenomena, such as the direction of the wind, the temperature from day to day, the occurrence of storms, together with data regarding contemporaneous phenomena, such as the appearance in spring of the first frog, toad, or snake; the end of the period of hibernation of certain mammals; the leafing of different trees and the flowering of various plants; and the breaking up of the ice in the rivers and lakes—all these throw much light upon the causes which induce, and the conditions which influence or control, migration.

More than a thousand observers are now at work gathering data for the solution of these problems. Never before have so many persons worked together and systematically for the solution of any great question in science. Observers are at work in every State and Territory in the Union, besides a number in the West Indies, Mexico, and Canada. The interest of the lighthouse-keepers has been enlisted, and many of them are doing excellent service.

The most southern station in the United States is at Sombrero Key, at the southern end of Florida, while the most northern is at Point Barrow, Alaska, more than four thousand miles away. From New Brunswick and Maine on the east, the stations extend across the continent to California, Oregon, and Vancouver's Island. And from the time a bird crosses our southern border in early spring-time until it reaches its breeding-ground, wherever that may be, it is under the careful surveillance of these inquiring spies. Its every movement is watched and recorded, and by the time it has reached its summer home, reared its brood, and returned again to its winter resort, few, indeed, are the important facts in its life-history which have not been made a subject of note by one or another of these observers. Thus the records are made from year to year, and even now hundreds of note-books all over our country contain thousands of entries to the credit or debit of our birds for the last four years. All this, and the Union has just begun its work!

As an illustration, let me ask your attention to the record of a beautiful and familiar bird—the Baltimore Oriole. After spending the winter within the tropics, it returns to our Southern borders in early April. The record for 1884 shows that it appeared at Rodney, Mississippi, April 7th ; at Oxford, April 15th ; at Anna, Illinois, April 18th ; at St. Louis, April 19th ; at Glasgow, Missouri, April 23d ; Jacksonville, Illinois, April 27th ; Liter, Illinois, and Coralville, Iowa, May 2d ; Des Moines, May 4th ; Racine and Jefferson, Wisconsin, May 6th ; Pine Bend, Minnesota, May 13th ; Elk River, May 14th ; and Oak Point, Manitoba, May 25th. East of the Mississippi, the record shows that it appeared in Jessamine County, Kentucky, April 18th ; at Bloomington, Indiana, April 21st ; at Camden, April 24th ; Petersburg, Michigan, April 30th ; Battle Creek, May 1st ; Sing Sing, New York, May 2d ; Lockport, May 4th ; Painted Rock, May 5th ; Locust Grove and Auburn, May 6th ; Watertown, May 11th ; Lake George, May 13th ; Brewer, Maine, May 16th ; and Montreal, Canada, May 24th.

The average rate of speed from Rodney to St. Louis was twenty-five miles per day, while the average daily rate for the entire distance —Rodney to Oak Point—was twenty-seven miles. The species seemed to move in greatest numbers about April 29th and 30th, filling up the whole country already reached by the vanguard.

The various reports show that the rate was remarkably uniform throughout the thirteen hundred miles, and that, though it increased very slightly to the northward, it nowhere varied greatly from the average rate—twenty-seven miles per day.

This bird is also very regular as to the time of its arrival at any given place from year to year. For the last four years the first arrivals have been seen here (Bloomington, Indiana) on April 20th, 21st, 20th and 21st. At Camden, one hundred miles north of this place, April 28th, 24th, 21st, 24th, and 25th, are the dates for the last five years. At Locke, Michigan, the record for twenty-five years (from 1856 to 1880), gives April 28th as the earliest date, and May 11th as the latest. The average date for the twenty-five years was May 5th, and it is interesting to know that this average date, May 5th, is the date upon which the first arrivals were seen for *six* of the twenty-five years. But the oriole is a late migrant, and therefore not so greatly influenced in its movements by the weather as are many other species. The late migrants, those which do not begin their northward flight until the weather has become in a measure settled, have been found to be the most regular in their movements. The early migrants are the ones which advance or retreat as the weather favors or prevents. The swallows and martins are excellent examples of this class, and their wide range has enabled them to be studied more, perhaps, than any other birds. As Dr. Coues has said, they are thoroughly cosmopolitan; their northward range reaches into the Arctic zone, and in the South the explorer has never gone so far that he did not find the swallows there. Insectivorous as to food, they must of necessity move with the appearance of insect-life, while their recession from the North is urged as well by their delicacy of organization and consequent susceptibility to cold, as by a failure in the food-supply. The prowess of their pinion has been the astonishment and admiration of all. The comings of the swallows have passed into proverb, and their leave-takings have been rehearsed in folk-lore among the signs of waning times. They have figured in augury; their flight is barometric, for they *soar* on clear, warm days, and skim the surface of the ground in heavy, falling weather, perhaps neither always nor entirely in the wake of insects upon which they feed. These birds cross our Southern border when the weather is yet cold and changeable. The record for the purple martin for 1884 shows that the first four degrees of latitude were passed at a rate of sixteen miles per day; the next two and one-half degrees at twelve miles; the next four and one-half degrees at sixty-three miles; and the last two and one-half degrees at but ten miles per day—making an average for the entire distance of eighteen miles per day. This record shows us a species very irregular in its rate of speed, and it is easily shown that this irregularity is due to the vicissitudes of the weather.

From observations such as these much has been learned regarding the rate at which various other species migrate. Data on fifty-eight species for 1883, for four hundred and twenty miles, show the average rate to have been twenty-three miles per day. Data on not quite so many species for 1884 show the average rate, for eight hundred and sixty-one miles, to have been exactly the same as for 1883. Twenty-five species gave an average daily rate of nineteen miles for March, twenty-three miles for April, and twenty-six miles for May, thus indicating—what I believe to be true—that the speed at which most species migrate increases toward the northern limit. This was one of the first important facts in migration observed and pointed out by Professor W. W. Cooke, and subsequent observations have all tended to prove the correctness of his views.

Were migration a steady movement, with the same individuals always in the lead, we might determine the exact rate of speed for many different species, but the movement resembles rather a game of leap-frog, and the leaders are constantly changing. Those individuals which arrive first at any given place are the birds of that species which will remain there to breed, while those in the rear pass on farther north. "The vanguard is thus constantly arresting itself, and the forward movement must await the arrival of a new corps, which may be near at hand or far behind. Migration is, then, a series of overlappings, and the real is evidently much greater than the apparent speed."

It has also been noticed that, as a rule, any given species migrates earlier up the Atlantic seaboard or the Mississippi Valley than it does across the more arid plains to the west; the first arrivals appear here from four to seven days earlier than in Kansas directly west of us.

The cause, no doubt, lies in the difference in the character of the vegetation.

One of the most difficult, as well as most interesting, questions in bird-migration has been, How are birds guided in their flight? *By instinct*, has been the usual answer; but, thanks to the labors of such men as Cooke, Allen, Brewster, and Scott, the question is now better understood. Recent observations made at lighthouses and astronomical observatories go to show that many, if not most, of our smaller birds fly at very great heights while migrating—heights even as great as *one to two miles.* And we now well know that "there are certain definite routes or paths along which birds pass in especially great numbers. These are usually coast-lines, river-valleys, or continuous mountain-ranges. Toward these converge innumerable less-frequented paths, each of which in turn has still smaller tributaries of its own. Thus bird-streams, like brooks, flow into common channels, and each particular region may be said to have its bird- as well as water-shed."

Perhaps the greater part of our birds migrate almost exclusively by night, and it seems true that clear, pleasant nights are selected during which to perform their migrations. That most species are unable to foretell the weather, even for a few hours, seems to be true; for during the migrations, if the early part of the night be clear, and a storm or severe rain come up later in the night, the birds will be stopped in their flight. On mornings after such nights I have always found more birds than at any other time. If the rain brought with it any considerable lowering of temperature, the woods and groves would be full of arrested migrants during the next day. These birds had evidently *started* when the sky was clear and the weather favorable.

Keeping these various facts in mind, it becomes quite easy to see how birds are guided in their course. From the great height at which they fly the whole country appears as a map upon which, in the light of moon and stars, the coast-lines, river systems, and mountain-ranges are outlined in every direction for many miles. "Guided by such landmarks as these, the older birds can have little difficulty in following paths they have repeatedly traversed before, and these direct and lead the flight of the younger birds." Mr. William Brewster, in his recent excellent paper on this subject,* and from which I have freely quoted, shows that, while the birds often migrate in waves or flocks, the different flocks do not move independently of each other. He believes that the flocks do not fly in close order, but scatter so as to approach or mingle with the stragglers or advance guard of other flocks, "thus in effect forming a continuous but straggling army, often hundreds of miles in length, and varying in breadth with the character of the country over which it is passing."

But when all is said, a great part of the details concerning the

* "Memoir of the Nuttall Ornithological Club," No. 1. Cambridge, 1886.

facts upon which these conclusions are based, remains to be worked out. Much remains to be done before we can fully understand the forces which impel and enable the bird creation to perform those long and perilous journeys across the depths of air and tracts of ocean, to seek for warmth and food in distant lands, and to return in season to their winter or summer homes.

A REMARKABLE EXPLOSION.

By Professor L. R. F. GRIFFIN.

MODERN industrial operations necessarily employ great quantities of powerful explosives, of which gunpowder and some of the forms of nitroglycerin are the most important. Nitroglycerin, for convenience in handling, is now commonly absorbed by Richmond infusorial earth, and is then known as dynamite. The use of these substances is not confined to the country, where they can be stored with comparative safety, but many engineering operations in cities require their aid to secure economical construction. This often necessitates their storage in considerable quantities, so that it becomes a source of danger. Special precautions are necessary to reduce the danger as much as possible, and to confine the effects of any accidental explosion within the narrowest limits. Usually, making the buildings used as magazines low, with strong walls and very light roofs, has been considered sufficient. Then, if explosion comes through accident, the explosive material spends its force upward, and the only damage to neighboring property arises from the shock given to the air. This plan may have been ample protection when gunpowder alone was stored, but the large substitution of dynamite in blasting has led to storing that explosive in the magazines, and a recent occurrence dangerously near Chicago has shown that it is by no means sufficient.

On Sunday morning, August 29th, Chicago and places in its immediate vicinity were startled by a sudden jar, followed by a dull thud, as of a distant gun of large size. It was sufficiently violent to shake buildings six miles distant, so that, although a very severe thunderstorm was occurring at the time, guests in some of the hotels rushed frantically down-stairs, suspecting an earthquake. Plaster fell in the Immanuel Church, more than five miles away, so that it was at first supposed to have been struck by lightning, and a large plate-glass window in the Board of Trade building, about seven miles distant, was cracked, and the clock on its tower was put back three seconds. An examination showed that Laflin & Rand's powder-magazine, one of a group of eleven, standing on a comparatively open area of some forty acres, about a mile and a half west of the village of Brighton, seven miles distant from the center of the city, had exploded, being struck by lightning. It contained at the time some fifty tons of ordinary gunpowder and fifteen tons of dynamite. The brick walls of the building were pulverized and scattered over a wide area; the limestone foundation was torn up, and a large part of the material broken into small pieces, the most of it carried through the air from forty to eighty rods; and a hole was torn in the ground, there mainly tough clay, about one hundred and fifty feet long, forty feet wide, and from ten to twenty feet deep. All the buildings in the immediate vicinity were demolished, while those which stood within reach of the flying stones were more or less riddled. The loss of life was very small, considering the extent of the damage, only one person having been killed outright, although several others were severely injured, of whom some have since died.

Such are the primary facts connected with the explosion itself. An examination of the ground in the vicinity, and of many of the buildings ruined near by, together with others at considerable distance more or less injured, has developed certain minor facts that bear upon the general subject of explosions. Especially do they seem to show that such explosions may produce an earth-wave which may do damage at great distances, the undulation of the ground displacing objects, cracking walls, and shattering glass much like an earthquake in miniature. Sometimes this may possibly prove the source of the principal destruction.

Looking directly at the destruction itself, the results of the explosion appeared as follows: The buildings nearest the wrecked magazine were all crushed together, and, so far as could be determined from the ruins themselves, were pushed away bodily from the demolished building for a short distance, not more than one or two feet. This shows that the explosives instantly produced a very large volume of gas, which forced itself against the surrounding air, and condensed it very quickly, until it gave way in the direction of the least resistance, which would necessarily be upward. This condition was confined to a small circle, for, while such a condensation would produce a wave of air, the mass bodily displaced must be confined within comparatively narrow limits. Displacement would not appear beyond. Fortunately, at Brighton, no other magazine stood within this area, so that the dynamite in the others was unaffected by the shock, while the rain prevented the fire from spreading by means of dry powder. Outside of this area there was a narrow ring or circular strip of ground with a radius of not far from fifteen rods where comparatively little injury was done. One or two magazines stood in this region, and they escaped almost without injury, only being slightly battered by flying stones. Here the air was not moved as a mass either way. The changes of density to which it was subjected were of the nature of molecular movements rather than motion of any great mass of air.

Beyond that area the movement of the air was toward the point of the explosion. This was shown by the forcing of the glass outward in all of the more distant buildings, while the walls of at least one dwelling-house and of several of the magazines left standing were thrown down toward the wrecked magazine. Furthermore, the roof of one magazine was clearly lifted, and allowed to drop, besides being riddled with stones. These phenomena pointed clearly to diminished pressure of the external air produced by the explosion, as is noticed in a small way when any gun is fired. Since most of the magazines stood in this region, no blow was struck upon them, and there was nothing to explode the dynamite stored within, else the first explosion would have been followed by others in a series, and the damage multiplied.

These phenomena taken together seem to indicate the following as the steps by which the destruction was produced, though they followed so quickly that only delicate instruments would have distinguished them: First, the lightning exploded some of the black powder. The blow produced by this explosion detonated the dynamite, tearing up the ground to make the hole and breaking the foundation-stone into small pieces. Then the rest of the powder exploded, sending the fragments away in all directions.

It is very strange that when the danger from lightning is so well known—one of the same group of magazines was exploded by lightning in 1880—no precautions are taken by the owners for protection. The magazines are low structures, some of them roofed with slate, others with thin metal, in all cases very light, that they may offer but little resistance in case of explosion. The total neglect of precautions against lightning indicates a disregard of the known laws of electricity, or else the mistaken notion that a lightning-rod, by furnishing a good conductor, attracts the lightning, and thereby increases the danger in place of being a safe path for the current. When such buildings stand upon level ground, in open areas, they necessarily become the path of any descending flash. If the electricity goes through the building it becomes a source of danger, because it is likely to meet sufficient resistance to raise the temperature above the igniting-point of powder, and it must be carried completely around the powder to insure safety. A network of metal rods carried over the top of those whose roofs are slated, and given a sufficient ground connection, would be a complete protection; it would carry away all the electricity, usually silently. To protect those with metal roofs, nothing more would be required than wide strips of metal from the roof itself to the ground. Of course, in either case, great care must be taken to prevent scattering powder on the ground within reach of the electricity as it leaves the conductors. The problem of protection in this case has sometimes been compared with that of the protection of tanks in which petroleum is stored. This is a complete misconception. Protection of powder-magazines simply requires a proper conductor to carry off the electricity, silently if possible, but so completely as to allow no escape in case of a flash. There are no complicating conditions, such as petroleum-tanks present. Nothing, either in the material itself or in the air around, makes that a better conductor than neighboring objects. But, in the case of petroleum-tanks, gases are constantly rising from the petroleum and escaping into the air around, and particularly directly above. They frequently rise many feet above the tank, and experience proves that the gas, or the mixture of the air and gas, is a much better conductor than the air itself. So the tank is likely to become the path chosen by any descending flash, and the problem of protection is not simply to furnish a conductor from the top of the tank, but one that shall conduct the electricity from the top of the ascending gas, always an uncertain height. So far, no plan has proved completely successful.

The phenomena show clearly that two sources of danger arising from such terrific explosions must be guarded against. The glass broken within the first two miles proved a rush of air toward the destroyed magazine. The sudden up-rush of gas, the mass very highly heated, caused a vacuum, and the subsequent cooling added to the effect. The air rushed toward that vacuum from all directions, and when it was contained in a confined space, as a closed room, it quickly broke the glass, shattering it into small fragments, which fell outward. But the force which did this work was spent within a comparatively narrow area. Beyond that it only appeared as the back-and-forward movement of an ordinary sound-wave. The distance to which this was carried could not be determined, because beyond some seven or eight miles the report was not distinguished from the ordinary roll of the thunder.

This explosion produced an earth-wave as well as an air-wave. The force of the dynamite, exerted largely downward, not only tore the ground out to make the hole, but forced it away sidewise in all directions. This formed a ridge around the hole, and at the same time it produced a wave, that is, an up-and-down movement in the earth. One observer, who was sitting quietly in a chair about six miles from the magazine at the time of the explosion, described the sensation which he felt as a quick movement down and up again. He was not quite positive which preceded, the motion upward or downward, but he thought that downward. That would indicate that the upward motion of the earth was first, since the human body has the sensation of moving in the opposite direction to the motion of the wave, and that agrees with the appearance of the hole. This earth-wave made dishes rattle in all places where it was felt perceptibly. In the central part of Chicago many plate-glass windows were cracked. These were injured by the earth-wave, not by the air-wave. They were simply shattered from the motion of the surrounding walls, but were not forced either inward or outward. One observer stated that a pane of glass near him was cracked at the moment when he felt the shock, not when he heard the report, which was a little later. This shows that the earth-wave moved faster than the air-wave which produced the sound. There is also reason to believe that this earth-wave traveled much farther than the air-wave. A self-recording barometer in the laboratory of Lake Forest University, about thirty miles distant from Brighton village, showed a sudden movement of the mercury at about that time, which could be accounted for only by referring it to the wave of the explosion.* Probably this was not the limit of the movement. Unfortunately, there were no means of determining the rate at which this earth-wave moved. All these conditions combine to surround this remarkable explosion with peculiar interest.

THE SCIENTIFIC AGE.†

By Dr. WERNER SIEMENS.

THE Association of German Naturalists and Physicians, which is so numerously and brilliantly represented here, having sixty years ago raised the banner of free investigation in our fatherland, has since, by its meetings, held from place to place, made the sciences, which had been previously pursued only in the narrow circle of experts, accessible to the life of the public, and therefore serviceable. The step was one fruitful in results. With it began a new age for mankind, which we have a right to call the scientific age. Nature had, indeed, given to primitive man — only weakly equipped in bodily strength — mental power and the faculty of observation, as the strongest of all weapons, in aid of his struggle for existence, and had taught him something of the use of her forces, his growing knowledge of the suitable application of which early smoothed his way to a higher civilization; and the arts of the earlier ages could be developed in many fields to a height at which we may still wonder, and means could be afforded for the achievement of artistic results of a perfection which has not since been reached; but all this came about by the toilsome and often fallacious way of the accumulation of empirical, uncomprehended, and unconnected observations and experiments, or by a way which could only slowly lead to the development of higher degrees of civilization.

These stages in civilization, however, comprised only a narrowly limited circle of development, and constancy was wanting to them, for they were attached to the person, and perished with it. Hence we see that, in the course of time, many eras of local civilization have bloomed

* The same instrument clearly recorded the earthquake-movement of the evening of August 31st.

† An address delivered before the meeting of German Naturalists and Physicians, in Berlin, September 18, 1886. Translated for "The Popular Science Monthly."

out, to disappear amid the commotions of the following age without leaving a trace behind them. Even after the art of the mechanical multiplication of writings and pictures had made the achievements of mind the common good of mankind; after the foundations of our present science had been laid, and it had been recognized that unchangeable laws lie at the bottom of all natural phenomena, and the only sure way of learning these laws lay in questioning Nature herself, through properly directed experiments—still, scientific and technical progress was toilsome, slow, and insecure. There was still needed a coming out of learning into public life, an infection of empirical art by the spirit of modern science, to release it from the ban of the traditional and mechanical and raise it to the dignity of a scientific art.

We older men among you have had the good fortune to be witnesses of the immense impulse that has been given to human activity, in nearly all departments of life, by the vitalizing breath of natural science. We have also seen, on the other hand, how science has been advanced by the achievements of art; how art has brought to it a fullness of new phenomena and problems, and with these the stimulation to further investigations; and how, with the spread of scientific knowledge, a host of observers and fellow-workers have grown up to her, in whom, although they may not stand on the full height of scientific knowledge, the love of science has repeatedly made up for that lack.

I will not attempt here to follow up the history of the growth of natural science, and its offspring, scientific art, or to describe the powerful transforming influences which science and art together have exercised upon the spiritual and material development of our period. It has been done many times, in convincing words and a masterly manner.

For us older men it suffices to acquire a view of the great difference between the past and the present—to cast a brief glance back to our own youth. We can still recollect the time when steamboats and locomotives made their first feeble experimental trips; we still hear with credulous astonishment the news that light itself can be made to paint the picture which it renders visible to our eyes; that the mysterious new force, electricity, could transmit news with the velocity of lightning through whole continents and the oceans separating them; that the same force would separate metals, in fixed form, from their solutions; and that it could drive away the night with a light as clear as that of day. Who wonders to-day over these now self-evident things, without which our youth could hardly imagine a civilized life—to-day, in an age when, according to Reuleaux's calculations, several iron laborers work day and night for every civilized man; when millions of men and immense quantities of goods are carried great distances at velocities which were once hardly conceivable; when the world-binding telegraph is not sufficient for the wants of our commerce, and has to make way for the transmission of the living word through the telephone; when photography is at the service of all classes; and when the latest fruit of the association of science and art, electro-technics, is opening to man, in its rapid unfolding, ever-new regions of inconceivable extent for further research and useful applications of the forces of Nature? To the investigator—who, more than any other class of men, is accustomed to draw conclusions from the course of observed phenomena as to the law controlling them—it is, however, not the latest state of development, but its causes, and the laws on which they depend, that are of surpassing importance. The clearly recognizable law is that of the progressive acceleration of our present advance in civilization. Periods of development, which in former times required hundreds of years for their accomplishment, which in the beginning of our age needed decades, are now completed in years, and sometimes come into being in full perfection. This is the natural result of our highly perfected system of instruction, by which the acquisitions of science, and particularly the scientific method, have been introduced into the broad stream of art and popular life in all their forms of efficacy.

Thus we see how, by virtue of our now excellent system of communications, every new scientific thought is at once flashed through the whole civilized world, and how thousands endeavor to grasp it and to apply it in the most diverse spheres of life. Sometimes it may be only modest observations, sometimes only the overcoming of small impediments that stand in the way of the recognition of the scientific relations of phenomena. They may often be the point of departure for a new course of advance, previously quite unanticipated, but important for human life. The progressive development conditioned upon these principles will therefore continue, if man does not himself in his conceit interrupt it, as long as science keeps going on to higher degrees of knowledge. The deeper insight we get into the secret processes of Nature, the more we are convinced that we are still standing in the extreme outer court of science, that an as yet immeasurable field of work lies before us, and that it still appears at least very questionable whether man will ever reach a complete knowledge of Nature. There is, therefore, no ground for doubting the continuance of the progressive ascent of scientific and technical evolution, unless man himself interferes with it by conduct inimical to civilization. But even hostile attacks can henceforth cause only temporary interruptions in the course of development, or at most only partial reversions, for, in the presence of the printing of books and the wide diffusion of the results of modern civilization, the scientific and technical accomplishments of mankind can never again be lost. Moreover, the peoples who cultivate these arts and lift them higher acquire through them such a dominant ascendency, so great a fullness of power, that their subjection in the contest with uncivilized people, and the breaking out of a new barbaric age, appear impossible.

While we thus regard the present development of civilization as incessant and impregnable, the end to which it is tending remains hidden to us ; but we can discern from its beginnings the direction into which it is to turn the principles on which popular life has hitherto rested. For this purpose we need only to carry out further the changes which have been already begun. We can then easily perceive that, in the age of the reign of the sciences, severe manual labor, by which man has been very hardly and still is considerably oppressed in the struggle for existence, will be more and more reduced by the increasing utilization of natural forces in mechanical service, that the work that falls to man will become continually more of a mental character, while it will be his part to direct the work of iron laborers (or machines) but not himself to perform rough bodily labor. We see, further, that in the scientific age the necessaries of life and luxuries will be supplied with far less human toil, and that a much larger share of these products of labor will fall to each man at the expense of less working-time. We shall see, also, that, through scientific and properly directed cultivation, a very much larger quantity of food-products will be obtained from the soil than heretofore, and that the number of men devoted to this branch of industry may be correspondingly diminished. We shall find that through the improvement and greater expedition of communication and transportation an ever-more ready exchange of the products of different lands and climates will be made possible by which the life of men will be rendered more enjoyable and their existence assured against the consequences of local scarcities. It also appears very probable that chemistry in connection with electrotechnics will some time succeed in composing real food-substances out of the inexhaustible abundance of their elements everywhere present, and thereby make the number of those who may be supported independent of the ultimate productive capacity of the soil. This progressively augmenting facility in obtaining the material means of existence will, by the shortening of the working-time that will have to be applied to that purpose, afford to men the leisure they will need for their better mental cultivation ; the better perfected and cheapened making of mechanical reproductions of artistic creations will also prepare the way for bringing these works into the cottages, and will make art, beautifying the life and elevating the moral standard, accessible to all mankind, instead of to privileged classes only. We are strongly of the conviction that the light of science, penetrating more deeply into the whole of human society, combats in the most effective manner degrading superstitions and destructive fanaticism, and that we shall be able therefore to go on in proud satisfaction with the building up of the age of science, in the sure prospect that it will lead mankind to a better moral and material condition than it has been or is enjoying to-day.

Our complacency on this subject has been disturbed very recently by gloomy pessimistic views which have been formed in learned circles as well as in the broad popular strata, respecting the influence which the rapid advance of science and art is exercising upon the character of popular life, and respecting the end to which that advance is tending.

The questions have been raised and discussed whether man is really better and happier for all these achievements of science and art, or whether they do not rather lead to the destruction of all ideal qualities of good, and to a coarse pleasure-seeking; whether the inequality in the division of the goods and pleasures of life will not be magnified through them; and whether the opportunities for work of individuals will not be diminished through the growth of machine-industry and the division of labor resulting from it, and the laborer himself be brought into a more restrained, dependent condition than before; or, in short, whether, instead of the lordship of birth and the sword, there will not prevail the still more oppressive rule of inherited or acquired wealth.

It can not be denied that there is now some show of justification for these gloomy anticipations. The rapid and continuous advance of scientific technics must necessarily, as it goes on, have a disturbing effect on many branches of industry. Better working methods may in many ways cause production to rise faster than consumption, and reduce the demand for labor, while manual labor, which formerly employed a much larger number of workmen to produce the same results, will no longer be able to compete with special machines. The like may be observed in the production of food-materials. Cheaper means of transportation are bringing to the old civilized lands the products in masses of thinly inhabited regions, whose virgin soils are not yet in need of artificial fertilization, but in which the scarcity of labor has led to the perfection of mechanical processes. It is true that scientific art provides means of equalizing these disadvantages by more rational methods of fertilizing and working; yet it is very hard to replace old accustomed but untenable conditions by better ones. Complaints are multiplying over the general depression in prices, and the falling off of the demand for labor, and the strangest theories are proposed for curing these evils by the isolation of certain lands against the products of others, and by forced limitations of production. The adherents of such theories go so far as to deny all utility to mankind of the scientific tendency, and to dream of a return to the methods of former presumed happier days. They do not recollect that, in this case, the number of men would also have to be brought back to the old figure. The number of happy shepherds and huntsmen is very small, and yet it must enter as an essential factor into the estimation of the greater or less prosperity of any period. It is a very hard but at the same time an unalterable social law, that all transitions to other, even if they be better, conditions, are connected with suffering. It is, therefore, certainly a humane proceeding to alleviate these sufferings to the present generation by a careful direction and partial limitation of the new, continually reverting revolutions of the social conditions of popular life; but it would be hopeless to try to stop the stream of this development, or to turn it back. It must necessarily follow its predestined course, and those countries and peoples will be least affected by its disturbing influence, and will be the first to participate in the benefits of the scientific age, which do the most to bring it on. But that the coming age will really present better conditions to mankind, and will heal again the wounds that it makes, notwithstanding the unavoidable inconveniences of the transition to new modes, is recognizable from many signs.

Is not the generally apparent lowering of the prices of all the necessaries of life and products of labor with a simultaneous, vastly increased consumption, an indubitable evidence that the human labor required to provide them has become less as well as lighter than before? And that the tendency of the development is such that men in the future will have to labor a much shorter time to provide for their needs? Does not also the fact, evident at the same time, that wages are not falling in a corresponding degree with prices, show that the lot of the working-classes will be a continuously improving one as the scientific age advances? Cheaper production of necessaries means the same thing as higher wages. Higher wages, and shorter hours of work! This louder and louder sounding demand of the so-called working-classes will be realized, therefore, as the natural result of scientific progress. For, except for crises and states of transition, no more will be made than is used, and the average time of work will of necessity diminish with the augmented speed and ease of production.

Another generally evident fact is the reduction of interest. To discern the significance of this fact, we must keep in view that capital—the savings of wages, as political economy calls it—is the standard of value of all wealth. His own or borrowed capital enables a man to obtain the usufruct of the labor of other men. If capital were really abolished, as fanatical and mistaken men are trying to have done, mankind would fall back into a condition of barbarism in which every one would be relegated to the work of his own hands for the provision of necessaries. But the demand for capital can not keep pace with its increase, because the arrangements for the production of goods are growing more facile, simpler, and cheaper. There is, therefore—always allowing for the transitional variations and violent disturbances of natural progress—a larger average accumulation of capital than can be usefully applied; or, in other words, an overproduction of capital is taking place, which must find, and is, in fact, already finding, its expression in a reduction of the rates of interest. The value of the savings of former labor, or of capital, will, therefore, continue to decline in comparison with the labor of the present, and must in the course of time be annihilated.

For the other and seemingly the most weighty objection of the opponents of our social progress—that by its operation the larger number are condemned to work in large factories, and that in the progressive division of labor no room is left for the free exertion of individuals—for this, also, the natural course of the advance of the scientific age bears the remedy in itself. The necessity of large factories for the cheap production of useful articles depends essentially on the present imperfection of machine technics. Large machines just now give cheaper effects than small ones, and the introduction of the latter into the houses of workmen is still beset with great difficulties. But ingenuity will certainly succeed in overcoming the impediments in the way of the return to competitive manual labor, by bringing cheapened mechanical powers, the basis of all industry, into the smaller shops and workmen's homes. Not a number of great factories in the hands of rich capitalists, in which the "slaves of toil" shall wear out their hard existence, is to be the ending of the development of the age of science, but the return to individual labor, or, where the circumstances call for it, the conduct of co-operative establishments by associations of workmen, for which a sound basis has first been furnished by the general spread of knowledge and training, and the possibility of a cheapened supply of capital.

The complaint is likewise unjust that the study of science, and the application of the natural forces to the arts, give a material tendency to men, making them vain in their knowledge and power, and diverting them from ideal aims.

The more deeply we look into the harmonious administration of the powers of Nature, regulated by eternally unchangeable laws, yet so profoundly veiled from our full understanding, the more, inversely, we feel ourselves moved to an humble modesty; the smaller appears the scope of our knowledge, the more earnest is our effort to draw more from this inexhaustible fountain of knowledge and power, and the higher rises our admiration of the infinite regulating wisdom which pervades the entire creation. And the admiration of this infinite wisdom gives a new stimulus to that spirit of investigation, that devout pure love of knowledge, which finds its final object in itself, which has been lifted to a position of high honor in the German scholar, where it stands a hopeful mark to future generations.

Hence we should not be disturbed in our faith that our zeal in investigation and discovery will raise mankind to higher grades of civilization, will ennoble it and make it more amenable to ideal efforts, and that the dawning scientific age will diminish its suffering and disease, heighten its enjoyment, and make it better, happier, and more satisfied with its lot. And, although we may not always see clearly the conviction that the light of truth which we are seeking for will not lead us into error, and that the fullness of power which it gives to man can not depress him, but must raise him to a higher degree of the way that leads to these better conditions, we shall yet hold fast to being.

ON THE TRUE AIM OF PHYSIOLOGY.*

By Professor W. PREYER,
of the University of Jena.

FOR a long while I have felt the desire to answer in a popular treatise the question, What ways and aims ought physiology to pursue? Most naturalists consider the explanation of all phenomena, including those of living bodies, only satisfactory if mechanical—that is to say, if, in strict logical sequence, it is based upon the principles of modern physics as taught by Galileo nearly three centuries ago. Thus, G. Kirchhoff considers the highest aim which the natural sciences have to strive for to be the discovery of the "forces" existing in Nature and of the condition of "matter"; in other words, "the explanation of all natural phenomena by means of mechanical laws." The fact that besides the forces, which mechanics has to deal with, there exist, too, chemical forces independent of the former, is illustrated by an hypothesis: "The same particles of matter, which at a greater distance affect each other only through gravitation, manifest, when placed in proper proximity, molecular forces, which appear in their protean forms, now as forces of elasticity, of cohesion and adhesion, now as forces of chemical affinity." The proof to what extent chemical affinity is a molecular force dependent on the unequal proximity of bodies affecting each other chemically, is wanting. It also remains an open question whether at greater distances masses act upon each other only through gravitation. But, lest it should be inferred that inorganic nature only must be explained mechanically, Professor Kirchhoff, in accord with many naturalists, adds: "We must confess that at present we possess but little knowledge of the condition of matter as well as of the forces through which its particles act upon each other, and that our comprehension of natural phenomena, even of those connected with inorganic bodies, is as yet very imperfect. The same may be said with respect to the much more complex processes which take place in plants and in animate bodies. In either case a true conception can not be formed so long as the mechanical theory has not been satisfactorily demonstrated. This goal never will be reached by the natural sciences, but the mere fact of its having been recognized as such gives a certain satisfaction, and in approaching it we experience that highest enjoyment which the investigation of the phenomena of Nature affords."

I am unable to share that satisfaction, since I do not recognize such a goal as the true one, nor does the approach to it afford that high enjoyment, because of our progress being constantly impeded by facts. The processes in a living body, even in mere protoplasm, can not pos-

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sibly be entirely based on mechanics, nor can we meet the difficulty by substituting for "mechanics" the highest physics and chemistry, including consummate molecular mechanics. For physics treats only of phenomena dependent on motion—that is, changes in space, the forces, the causes of motion, and the causes of changes in motion, as formulated by human intelligence, are its proper domain. Chemistry, which ascribes to Nature one single force—that of affinity—because it does not need any other, deals with substances alone, with the various elements of matter. Processes which can not be attributed to either changes of forces, i. e., change of one force into another, or to changes of substances, i. e., the transformation of the latter through separation and combination, are not physical and not chemical; consequently, neither physics nor chemistry is engaged in their investigation. Such processes, however, take place in animate bodies—the feeling of hunger, for instance, which the most thorough physical and chemical inquiry fails to explain, though its necessary conditions and consequences may be ascertained.

During the fertilization and division of the ovum, during the differentiation of embryonic forms, during the gradual transformation of fetal and aimless into functionary movements of muscles and nerves, and during the perfection of the organs of sense and of the nerve-centers after birth, a series of processes occur which are entirely outside the domain of both the physicist and the chemist. They are not called upon to deal with the problems of heredity and psychogenesis, as they do not present themselves in the physical and chemical world.

For the very reason that there is *one* world only, all dualistic systems are untenable. The mechanical theory asserts, though illogically, that, by means of its one-sided principles, all things will in time be understood. The dualistic or vitalistic theory starts by assuming the existence of a contrast in the world, the forces in the living body being different from those in the crystal, those in the brain not the same as those in the material of which the brain is composed, those in young protoplasm not the same as in the old. Now it devolves upon physiology to show how to eliminate this "vitalism" which encumbers its path. Physiological inquiry must attach more importance to the conception of evolution. Morphology, in applying the method of evolution in all its departments, has gained a higher repute than ever. The anatomical phylogenetic history of man, in connection with his embryological and later-history of development, may indeed furnish an explanation of the marvelous fitness and natural evolution of the human body.

It is, therefore, surprising that in that domain of the science treating of living bodies, in physiology, or the science of the functions, it hitherto has not been applied at all, or only occasionally and reluctantly. The neglect is due partly to the erroneous opinion that not the physiological function, but only its substratum the bodily organ, is capable of evolution. The organ, that much is certain, develops—that is, it passes through a series of transformations before assuming its final form. Any part of every organism will furnish the proof. But what determines the final form during phylogenetic evolution? I answer, Function. With its assertion begins the differentiation of the substratum of primitive beings. It is not the organ from which function derives its origin, but just the reverse. The functions create their organs, or, to use a better definition, necessity determines the organic form, which hence becomes hereditary, and ultimately in the embryo of the higher animals in structure at least precedes function.

When the embryo of the land-salamander, many months previous to the normal time of its entry into the world, is taken out of the egg and kept in water well supplied with oxygen, neither too warm nor too cold, nor too dark, and amply fed with small living water-animals, and if care is taken that the creature can not get out of the water, its organism will change. It has to inhale the oxygen dissolved in the water, not that of the atmosphere, like its parents breathing with lungs. Its lungs therefore remain undeveloped, but by way of compensation strong gills appear at each side of the head. The originally very feeble function of respiration through gills, in conformity with the increased demands of the growing body, creates a new organ, or calls forth one possessed by its remote ancestors. The animal, moreover, feels the necessity to swim, not to creep, like its terrestrial parents. Its four extremities, therefore, become mere rudimentary appendages, while, on the other hand, a vigorous rudder-tail develops. The function of swimming calls forth fins, new organs which the parents lack. Thus a substantially new animal is produced, which elsewhere does not exist, and which shows how through the development of new functions new organs are formed, or, as it were, resuscitated.

This principle applies not only to particular cases with artificially created conditions but to all functions. All of them precede the organs devoted to their exclusive service. All of them originate through competition for the necessaries of life. At first a simple want is easily satisfied by simple means, but gradually the organism is called upon to meet numerous demands requiring complex contrivances through differentiation.

Instruments, apparatus, engines, are tools or organs invented by human beings, because the wants of better food, better air, better water, or the necessity of saving space and time, or of having means of communication, protection etc., become more and more pressing among them. They have, as it were, become part of the organism. Such newly invented artificial organs as the spectacles, the watch, the shoe, have all a long history of evolution.

The kitchen, with all its large and small utensils for the cooking and mixing and chemical preparation of the raw produce of the animal and vegetable kingdoms, may be looked upon as one single digestive apparatus, an ante-stomach whose history of evolution, covering thousands of years, distinctly shows the increasing demands for digestibility and relish, the need to diminish the work of the teeth and to ease the process of mastication. The starting-point is here the function of taking and assimilating food.

In this sense it is not only permissible but necessary to speak of an evolution of physiological functions. No organic structure develops without having an activity, a necessity, to intensify this activity for its cause. The cause of this increase in activity or differentiation is simply functional evolution. It is the principle of all organic growth, of all morphological evolution, and, wherever it decreases or ceases, the latter at once retrogrades. Without function, no organic formation; increase of function, organic differentiation; cessation of function, organic retrogression.

In applying this principle to the physical and mental activities of the healthy and the sick human being, physiological inquiry must of necessity be carried on in two directions. Since it is necessary to know not only the nature of functions, but also how they have evolved, the evolving living body, the embryo, must be physiologically examined. That is one direction. To compare the complex functions of man, the most complex of all beings, with the less perfected functions of animals—and of plants too—is the other task. Physiology must be comparative only, said, in 1826, Johannes Müller. The genetic and the comparative science of functions go together. Both, as yet incipient, must by-and-by become the basis of the biology of the future.

Each single function of man must step by step be followed back to its first manifestation in the living ovum, in the individual life, and in that line of animals which nearest approach his ancestors, and hence further up to the merely living protoplasm which is neither animal nor vegetable. It then may dawn on us whence are derived the high and lower functions—e. g., speaking and seeing, as well as breathing and walking, and how they have become as they are.

But if we continue to inquire without comparing, we can not arrive at such knowledge; but by merely observing in which way in *one* instance a function is performing, we may, with great expenditure of labor and ingenuity, time and material sacrifices, find only how it may be or may have been, not how it is and has been. The preference since Galvani's time for the frog as an object of physiological inquiry, the too frequent use of dogs, rabbits, and Guinea-pigs, already called the domestic animals of physiologists; and the levity with which the discoveries made on these few animals, so widely differing from man, have sometimes been applied to the latter, have caused many errors. It is gratifying that at least some of the younger investigators choose also other objects of inquiry, but they should not be the exception. By no means can it be urged that it is too difficult to procure the material, and that in zoölogical gardens physiological laboratories can not well be established. Not every physiologist will, like the great Harvey, get a deer-park placed at his disposal by his king; but the forests and fields, the lakes and rivers of Germany yield abundant material to the investigator, and with our modern means of communication living animals may be quickly dispatched from zoölogical gardens to physiological institutes. The latter, however, avail themselves too little of their opportunities.

All the working material that can be obtained in this way, however, is but a very small fraction of what the sea affords, and he who earnestly desires to further comparative physiology without laboriously hunting for objects for examination must go to the sea-shore. But in order better to approach the end in view without waste of time, laboratories for physiologists ought to be constructed on the coast, especially in places where varieties abound. The aquaria which are being erected in increasing numbers in Great Britain and France are admirably adapted to the purpose. The zoölogical station at Naples, however, which owes its existence to the tireless energy of Professor Anton Dohrn, has as yet no equal. Its scientific achievements, its international character, its admirable organization, its favorable location, make it, for purposes of physiological and morphological investigations, especially desirable. Having enjoyed the privilege of working there during one winter, I am able to speak from experience of the eminent services which the high-minded founder and manager of the Naples Institute, the first of its kind, has rendered to the furtherance of the true physiology. He, the first to accept functional change as the principle of morphological and philogenetic inquiry, has also been the first to recognize the advantages of the physiological investigations of marine animals.

It must frequently pain a naturalist to witness how untold living treasure coming from the sea up to the surface in aquaria is allowed to return to the dark deep as unworthy of observation and examination. And yet by experimenting on the superabundant and to the physiologist irresistible wonders of the sea, more light may be thrown on the relations of the phenomena of life, on the becoming and being of the higher and the highest, and also the mental functions, than is to be obtained by limiting ourselves, as has been the custom, to a few animals of our own geographical environment. When, for instance, we observe how star-fishes, generally supposed to be capable of reflex movements only, will free themselves from fetters and difficult situations, like highly intelligent beings, in an amazingly dexterous manner and with the nicest adaptiveness, how, with the precision and alacrity of expert gymnasts they will vault from a piece of driftwood on to the solid rock, or, while freely suspended, will change the dorsal attitude into the normal one, remove entangled obstacles with their long spikes braced against each other as circumstances require, like long-armed or short-armed levers, and otherwise accomplish unexpected feats, we have the proof not only that the prevailing views in regard to the lack of intelligence of such low organisms of the animal kingdom are erroneous, but also that their mental functions may be highly developed without such intricate development of the nervous system as is possessed by the higher organized beings of less psychic capability. I have witnessed how a South-Sea Islander was unable to take off a coat which had been put on him in the regular way. It did not occur to him to stretch one arm backward. The star-fish, however, easily frees itself in the best possible manner from rings, firmly knotted threadings, wrappings, and incumbrances, with which it has not previously come in contact. Such observations must necessarily influence the principles of inquiry. A large brain is required not for one single intellectual act but for a multiplicity. I have found that when many of the tiny ganglionic cells of the Echinodermata remain in organic connection with only one spike, they are capable of doing more work both as to quantity and quality than a smaller number will accomplish under the same conditions. Hence it would appear that also with the higher animals, and with man, the greater intelligence depends on the greater number of ganglionic cells and their combined action rather than on the relatively larger brain. In this way the inquiry into the movements of marine animals directly leads up to the physiology of the brain. Through comparison with that of the animal only is human psychic activity to be understood, for it is the last and highest link of a long chain of evolution whose gradations can only be recognized by the aid of philogeny and physiology—i. e., through the comparison and the history of evolution of functions.

The most attractive problems of the future lie in this direction, and, as soon as the labors in this field have borne more fruit, the different views which now oppose each other will become reconciled. But in other departments of science, too, the perception is dawning that it is of far greater significance to ascertain by comparison the becoming, the growing, the evolution, than to describe the phenomenon by itself just as it happens to present itself to the observer whenever he thinks fit to observe.

In 1861 one of the foremost chemists of the period declared, "The relations of a body to what it has been and to what it may become are the essential part of chemistry" (Kékulé). Instead of "chemistry," we might just as well say "morphology, or history of evolution." The same principle applies to physics, to astronomy, geology, and in a certain sense even to the science of languages. For physics, too, deals with the relations of a conglomeration of forces or of a body to its own past and future. Its ideal is to predict the future of a body, and to estimate its past from its present appearance. Astronomy, in this respect, surpasses all sciences, because its prophecies are being verified with most precision. Geology is essentially the history of the evolution of the globe; comparative philology endeavors, as it were, to find out, from the relations of living languages to the dead and living ones, the pedigree of each idiom, just as the zoölogist is trying to discover the origin of present animals from their relations to the fossils and to each other. Everywhere thinking naturalists are tacitly or confessedly influenced by ideas closely resembling the conception of evolution. All are anxious to ascertain the past and future conditions from existing ones, which is the very essence of evolution. The nature of the transition of one condition into another, its laws, its velocity, its consequences, all these differ in the special departments, not the general fact of the change of condition itself. When, at the same time, the sunbeams warm the human body and delight the eye with glowing colors, when they dye the young plant green and the sensitive glass plate violet; when they move the radiometer, make the telephone resound, allure millions of tiny winged insects into the air, banish millions of other beings which shun the light under ground and to the depths of the waters, close night-blowing flowers while opening others bedecked with dew at the dawn of day—it is ever the one immense sun who, with the same life-giving and life-destroying rays, is working such different wonders. In like manner it is, with all natural sciences, the evolution theory which is producing the different conceptions of Nature. Every one is anxious to comprehend the true sequence of phenomena. All stand firmly on the impregnable basis of the "principle of sufficient reason," which states that every change must be preceded by a change and be followed by another. But when we ask, Which was the first, which the following? difference of opinion will arise: Is an animal, which has little capability, endowed with a simple organism, because it has as yet not been differentiated, or because it has retrograded in its descent from more highly developed beings? Such questions sometimes are extremely difficult to answer, and in these cases it devolves upon physiology to decide or at least to pronounce its weighty judgments. For whenever an organ retrogrades, function has disappeared much sooner than the rudimentary organ; but when, on the other hand, an organ is continuing to develop, function has appeared much sooner than the perfected organ. It would then have to be ascertained whether the organ in question is still possessed of a function, or has already lost it. If, for example, a perfected eye shows little or no sensitiveness to light, it must be in a state of retrogression; if it is very imperfect, and yet extremely sensitive to light, it is developing, while an eye of very simple structure which is not sensitive to light can only have become so through retrogression.

Embryonic eyes, of course, are in a state of progressive but individual development, while here we are only speaking of phyletic evolution. The inorganic sciences have similar questions to answer, though with them the conception of sensitiveness to light has a different meaning, and merely signifies receptibility, the capability of assimilation or of disintegration, without an admixture of feeling and sensitiveness in a physiological sense. But, to continue the illustration, the mere question whether decomposition through light is less felt by the bromide of silver of a photographic plate than by the protoplasm in the leaves of a tree which derive their green color from that light—this question is embarrassing to those who assign to animals alone the sense of feeling, for, since the highly excitable protoplasm of nerveless animals is likewise sensitive to light, and not to be distinguished from that of many plants, they must decide whether the former specifically differs from the latter, or whether both are equally incapable of feeling. In the former case they are called upon to point out the specific difference, which they can not do; in the other they must state where, proceeding from the lower to the higher organisms in the chain of animal creation, the inability of feeling ceases and the sense of feeling begins, which is equally impossible.

Thus, it is in accordance with facts to assume that there is no well-developed dividing line between beings capable and incapable of feeling, but that all matter is endowed with a certain *sense of feeling*, which, however, only with a definite and an extremely complex arrangement and vibration of the molecules will develop into *feeling*. The simple bodies, the dead elements, therefore, although partly very easily changed through slight influences, are, in spite of their dim sense of feeling, not able to feel perceptibly, but as soon as they become part of the ganglionic cell of the brain, or only of the living protoplasm (through assimilation of food), they, combined with others, will by indescribably complex vibrations cause feeling to arise like lightning whenever an impression is made on them.

Every physiological explanation must, above all, be in perfect accord with morphological, mechanical, and chemical facts; on that all physiologists lay the greatest stress, but I do not understand why, regardless of physiological facts, morphologists, physicists, and chemists should be allowed to declare their explanations and principles to be the only true ones, or even the only possible ones. It has been demonstrated that matter must have other fundamental properties besides those ascribed to it by physicists and chemists. The axiom of mechanics, "Matter is dead!" will soon become obsolete, since a sense of feeling is inherent in all matter. This supposition does not make the least alteration in the imposing structure of the physical and chemical sciences, because in their formulas the new factor is merely an infinitesimal quantity in proportion to the rest; but the imperceptible is not the less real than the perceptible, because of its imperceptibility.

No one can hear a single leaflet tremble in the wind, but during a storm the roaring of the forest, caused by many leaves rustling together, may reach awe-inspiring power. Similarly, each molecule of matter may feel imperceptibly little when vibrating by itself, while, together with many particles feeling likewise imperceptibly, it may co-operate in manifesting feeling, which, like lightning, arises and vanishes.

Through this conception, through acknowledging evolution and the sense of feeling, the whole of Nature may be brought in harmonious connection.

TURPENTINE-FARMING.

By L. W. ROBARTS.

FINDING myself in the pine-region of Southeast Georgia, and thinking that some information on the subject above named may not prove uninteresting to your readers, I will endeavor to tell to them that which has been imparted to me by those thoroughly conversant with the whole business.

A turpentine-farm consists of from five to forty crops of ten thousand five hundred boxes each. The work is sometimes carried on by the owners of the pine-forests themselves; again, the trees are leased out for a certain number of years, two or three being about the limit. Negro labor is principally employed in this section. The work commences in November, when the boxing of the trees begins. The boxes, which are cut sloping back into the trees about a foot from the ground, measure three inches back at bottom, four deep, and about seventeen in length. In March they are cornered; that is, a chip is taken off on both sides just above the ends of the boxes. Next the faces for dripping are cut V-shape between and above the places chipped. The number of faces on each tree depends upon its size, varying from one to three. Besides the original cutting of the faces, the trees are hacked once a week during the dripping-season with a peculiarly shaped knife suited to the purpose. The hacking increases the length of the faces, as one or two inches of bark are taken off above each time.

The dipping of the crude into barrels begins about the middle of March, and the boxes are emptied seven or eight times during the season. They hold from one to two quarts each, and from 10,000 boxes 210 barrels is considered a fair, 250 a fine yield. The first year's dripping is called "virgin," the second "yearling," and all after "old stuff." From eight barrels of crude they get two of spirits of turpentine, and five to five and a half of resin. Of the latter there are several grades: W. W., "water-white"; W. G., "window-glass"; M, next highest, and so on up the alphabet, but down in quality, to A, the letter J being omitted. The first drippings, if not scorched in boiling, make beautifully white, transparent resin; hence the name "water-white." The crude producing this can never be obtained from the trees after the first month's running; that for W. G., "window-glass," possibly, into July or August.

Sometimes dealers are imposed upon by agents, who, by a skillful handling of the brush, can change W. G. into W. W., and H. into K., and so pass the resin off for a higher grade than it really is.

The stilling begins about April. One pleasant afternoon, a few weeks since, one or two friends and myself strolled down to a still, about a mile distant from the farm-house. The stiller and his wife were most kind, and cheerfully answered my many questions. The still, which cost about six hundred dollars, was a rude structure of two stories, or rather a ground-floor with one story, roofed, but not closed in. Ascending the rough stairway, we reached the top of the huge caldron, into which are poured from eight to ten barrels of crude at a charge. The opening, only sufficiently large to admit of the turning of a barrel of crude over it when the boiler was being filled, was covered by a copper cap that, being lengthened out, formed a short pipe which, bending downward, united with the spiral pipe or "worm" that coiled itself in the huge still-tub of water near by. The water was conducted into this tub by a trough leading from a well, the buckets of which were drawn several feet above the mouth of the well to a convenient height. A pipe from a barrel of water led into the boiler, so that the water could be turned in whenever, in the judgment of the stiller, it was necessary. When the boiling began, the vapor, rising and entering the "worm," was condensed by the cold of the tub into water and spirits of turpentine, which poured out into a barrel on the ground-floor. From this barrel the turpentine only was conducted into another; this was easily accomplished by having the connecting-tube placed near the top of the barrel, higher than the water ever reached, the turpentine always rising to the top: this was prettily shown by the stillers catching from time to time a tumblerful and holding it up, when it could be seen that the separation was instantaneous. The stiller frequently places his ear at the end of the "worm," as by the sound from the boiler he can judge as to the expediency of adding water to the crude. The proportion of spirits to water that flows out should be as two to three; the quantity of the former of course decreases as the time for letting off the charge approaches, and it at last should stand only a half-inch on a glass of water. But when the demand for resin is greater than that for turpentine, the tendency is not to carry the boiling quite so far, as more turpentine may be left to the improvement of the resin; still, it should be taken out sufficiently to prevent the softening of the one and a half inch sample-cube, which is placed in the show-case of the merchant.

When, during the boiling, the necessary proportion of spirits to water for discharging is reached, the stiller removes the cap, lessens the heat—as there is great danger of scorching the resin—and, after giving the contents of the boiler a vigorous stirring, lets it out at the opening near the bottom, a boiling tide, into the three strainers placed one above another upon the ground-floor, through which it passes to the tank below. The upper strainer is of coarse wire, in which are caught the pieces of bark and other foreign substances that have escaped the wire skimmers when in the boiler; strainer No. 2 is of finer wire; No. 3 coarse, but covered with cotton-batting. When this mass of liquid has passed entirely through, the strainers are removed, and the still intensely hot resin is taken up by great dipperfuls and poured into barrels standing near. It must now be undisturbed until hard, as even putting a stick down into it injures the quality of the resin. The poorest crude, if taken off the furnace just at the right moment, gives W. W.; but if scorched the color is injured, and consequently the grade lowered.

The children around the still brought boxes containing flowers and brightly colored pictures, lying flat upon their bottoms, and the stiller poured a small quantity of the liquid resin upon them; this, continuing transparent, glazed them over and preserved the treasures. I still have a sprig of small leaves which he dipped for me that is coated over quite prettily. There are two or three discharges from the boiler each day.

All foreign matter taken from the crude, also the cotton-batting used in straining—in other words, the "dross"—although valuable as material for kindling, is frequently burned, as there is very little of it sent to market. I remember the dense smoke that caused the gentleman from the farm to hurry over to the still one afternoon, fearing that everything was being consumed, when it was only a bonfire of this most combustible material. In case of danger from fire to the still-house, the first step is to seal down the cap as rapidly as possible with mortar always kept mixed in a tub near by.

The resin is put in pine barrels; but oak barrels, made very tight, their seams being glued on the inside, are used for the turpentine. The uses of resin in the manufacture of soap, varnish, shellac, etc., and in various other ways, are numberless. The products of the turpentine-farms of this region are sent by steamer down the Altamaha to Doctortown, thence by rail to Savannah and Brunswick. Savannah is said to be the largest market for these commodities in the world.

Mr. Bolton King maintained, in the British Association, that the future of successful agriculture lies in large farms under skilled management, with plenty of capital, or in co-operative farming. It can enjoy the economic advantages of large capitalist farms, and is believed to be competent to realize the social ideal sought for. Such evidence as is at hand is favorable to the feasibility of engaging the co-operation of the laborers in enterprises of this kind, and there is not likely to be difficulty in finding the required capital; but the chief obstacle to the extension of association farms lies in the scarcity of skilled managers, who will have to be waited for till they can be trained.

RUSTIC SUPERSTITION.

THAT "the days of superstition are past" is an announcement frequently and triumphantly made by those who advocate the disestablishment or destruction of any institution or belief that happens not to be in accordance with their own interests or theories. Little, indeed, must such speakers know of the minds, not only of the poorer classes, but of those whose education, as one would suppose, should have raised them above the influence of the grosser and more vulgar forms of superstition. We are not now speaking of the newly invented astral bodies or telepathy; these are the latest refinements of spiritualism, and may die out; we refer to the fine old-fashioned belief in ghosts, witches, wizards, and "uncanniness," which is still far more prevalent than even the believers themselves realize, they being usually more or less ashamed of and reticent as to the faith that is in them.

Mr. Hardy, who has an unusual knowledge of rustic life and habits of thought, in a recent novel, "The Mayor of Casterbridge," gave a wonderful sketch of a local soothsayer, his patrons, and his profits; and though the date of the story lies as far as some fifty or more years behind us, there can be little doubt that the sorcerers of whom "Wide-oh" is the type still flourish in our midst. To this fact the daily papers bear witness, since we often read of some wretched old woman being haled before the bench, and sentenced to fine or a term of imprisonment for pretending to tell the fortunes of servant-girls with a pack of dirty cards or the dregs in a coffee-cup, though, by-the-way, there is considerable inconsistency in a legislation which punishes the old woman and yet permits turf-touters to advertise with impunity that they have the winner of the next three Derbies in their pockets, and are willing to part with the information on the transference of a certain number of half-crowns from those of a credulous public. Still, though the wise woman, usually a denizen of cities, is occasionally caught napping, owing perhaps to an infelicitous habit of mixing up magic with the reception of stolen goods, the wise man of the provinces is more wide-awake and carries on his trade without interference from the police, his specialty being the cure of warts, toothache, and certain cattle-diseases by incantation or other mystic rites.

We happened not long ago to meet a young, well-to-do, and well-educated farmer in a market town not on a market day, and in the course of conversation casually asked what particular business he had on hand. "A very bad toothache," he replied. The next and natural question was to inquire if he had "been and had it out." Blushing to his eyes he said: "I dare say you'll think me very foolish, sir, but I've been to a wise man to have the pain charmed away. Folks say as he's wonderful at that sort of thing, so I thought I might as well give him a trial." This announcement being received with the burst of laughter he evidently expected, he hastily added, "Believe it or not as you like, sir, as soon as he said something the pain went clean away, and I've been easy ever since." It was worse than useless to explain the well-known effect on the nerves, of a visit to any sort of dental operator, and the agriculturist wended his way to spread abroad the fame of his healer, and no doubt to suffer renewed agonies as soon as he got home. It may be added that under no circumstances will a countryman, if he can help it, have a tooth taken out by a regular practitioner—a baker, grocer, or blacksmith, with a local reputation of being "uncommon handy," is almost always resorted to for this extreme measure. It is but another form of provincial superstition.

The familiar occurrence of a mysterious ringing of bells by some occult agency is a never-failing source of awful joy to the country town or neighborhood to which this supposed supernatural manifestation is vouchsafed. The house thus favored is the constant center of thought, conversation, and pilgrimage; groups of true believers stand outside with upturned gaze, as though expecting to see the ghost appear out of one of the chimney-pots and address the audience from the roof, while those who are sufficiently in the intimacy of the terrified though flattered household to be admitted to the haunted dwelling, would not change places with Mr. Rider Haggard's heroes. And when the inevitable *dénoûment* comes, when the half-silly servant-girl or wholly mischievous boy has been accidentally discovered throwing a rolled-up stocking or cap at the bell, in the general disappointment and sense of injury which ensues, faith though shaken is not destroyed. A few steadfast ones gather together, and comfort each other with such sayings as "'Twas better to make believe as 'twas all nat'ral," "Folks don't like their housen to get a bad name," or "Don't tell I as any gell could have kept they bells ringing the night through"; and the lump of incredulity thus gradually releavened, the next announcement that the spirits are at work again finds acceptance ready as ever. It must be frankly admitted that churchyards have of late years fallen from their high estate in rural estimation as the recognized ghost's playground; not that a countryman would willingly linger within these precincts after nightfall, nor would he appoint such a tryst for his lady-love, but he no longer regards the burying-place with his former feeling of reverential fear. The reason of this change is not easy to discover, as it can hardly be attributed to intellectual enlightenment. Perhaps he has good grounds for his confidence. It may be that since the passing of Mr. Osborne Morgan's bill, the *manes* of the older and orthodoxically interred residents sulk in their sepulchres, holding themselves aloof from possible contact with new-comers "licensed to walk" under a Nonconformist ritual, and that these latter, out of respect to class prejudice, or from a feeling of diffidence unknown in a previous existence, shrink from obtruding themselves on public notice. If, however, churchyards have somewhat abated their terrors, it is as aforesaid owing to no decay of superstition; for certain lonely lanes or portions of roads supposed to be more or less haunted are still only willingly traversed in company or by daylight. And the peculiarity of these places is that they seldom, if ever, are the "walk" of any definite specter. The rustic, if he will talk on the subject at all, will tell you that he "have heard tell there's summat," but what "Summat" is, having no idea on the subject, he will certainly not attempt to express one; meanwhile "Summat" gallantly holds his allotted territory, and causes the belated villager to commit various acts of trespass in order to avoid Tom Tidler's ground.

"Summat" unfortunately does not always choose to live out-of-doors, as a landlord may find to his cost. Old farmhouses not unfrequently have a chamber set apart for the residence of this vaguest of phantoms; and as the growing-up family requires more room, the tenant will ask for partitions or fresh building rather than disturb "Summat" in his dusty though inhabitable apartment. A little way up the glen of Rothes, in Morayshire, is a large hillock, locally known as the "Doonie." A few years ago, and probably to this day, it had the reputation of being no canny after dusk. A Scotch "Summat" graced it with his presence, though in this particular instance he was probably originally inducted by illicit distillers, who sought his protection against disturbance in their business.

The old conventionally haunted family mansion, though fairly holding its own among the tenets of rustic superstition, does not—inasmuch as it is not open to the public—greatly exercise the rustic mind. The White Lady appears only on special occasions, the wheels of the invisible carriage rumble up only to that one door, and in neither case does the phenomenon bode evil to aught but the lawful proprietors of the ghost, though it is a drawback to service which has to be duly considered in the domestics' wages. Yet is there a country house we wot of in the west, where the atmosphere was so full of supernatural electricity, and so light a friction was necessary to secure its discharge, that the place acquired a local celebrity as inconvenient to the owner—who was non-resident, and wanted to find a tenant—as it was interesting to the neighborhood. In this case the disturbing agents were a skull and a couple of thigh-bones, said to have been the property of an ancestor who had been either hanged or murdered, both of which incidents had embellished the chronicles of a lively and aggressive race. Whether these relics had been collected from the gallows, or kept *in memoriam* of a coroner's inquest and a post-mortem examination, deponent sayeth not, nor is it known why they had been denied the rights of burial; but from some misplaced sentiment they were preserved, irreverently stowed in the cupboard of an attic, and there left to disturb the peace of the inmates, the specialty of these bones being, that if untouched they were as well-behaved remnants of mortality as could be desired, but if meddled with, and the cupboard seems to have been always unlocked, they instantly resented the affront with knockings, rustlings, banging of doors, steps on the staircase, and other manifestations of outraged spirits. All this was alarming enough, and there was for a long time considerable difficulty in finding a care-taker, the simple expedient of burying the bones or of locking them securely away never apparently having occurred to any one. At last an old family gamekeeper (whom it was supposed the family ghost might tolerate), with his wife and a mischievous boy of about ten, were installed in charge. Gamekeepers are not as a rule much troubled with nerves. Familiarity in this instance, as in most others, bred contempt, till in a year or two the only notice the old man took of a violent outbreak on the part of his spiritual associates was to remark, "*There's that dratted boy been a-playing wi' they bones again*," as if the youth were surreptitiously preparing to join an Ethiopian troupe!

Rain seldom fails us in England, and very rarely do we suffer from anything approaching to drought. The ordinary wells, pits, and springs suffice for the farmers' needs, and they can dispense with resort to magic arts in search of water. Yet in the provinces would a man be deemed worse than profane who should express doubt in the virtue of the divining-rod. It is true that search for hidden treasure is not as general a pursuit as it was before the days of the rural police; but when Dousterswivel makes his appearance, as he still does from time to time in quiet country towns, he can reckon upon many believers and a fair supply of victims.

Can we fail to join "Wide-oh"—Mr. Hardy's rural wizard—in his astonishment "that men could profess so little and believe so much at his house, when at church they professed so much and believed so little"?—*Saturday Review.*

SKETCH OF LEO LESQUEREUX.

By L. R. McCABE.

AMERICAN science owes an incalculable debt to the Geneva Revolutionary Council of 1848, that suppressed the Academy of Neufchâtel and sent to our shores Agassiz, Guyot, and Lesquereux. In the heart of Switzerland's mountain grandeur this illustrious trio first saw the light and drank of that love of Nature which, deepening with the years, peculiarly linked their lives. Agassiz had been in America two years, when he was joined by Guyot and Lesquereux, whose friendship had been formed while they were collaborators in the quaint Swiss town. Humboldt and Cuvier had showered their encomiums upon the great naturalist, and Continental Europe was heralding his praises, when the political changes of his native land brought him to the New World, where he became the leading mind in zoölogy, as Guyot was in physical geography, and Lesquereux in paleontological botany. The two former, full of years and rich in truths bequeathed to science, have passed away; while the latter, bearing lightly his fourscore years, still works actively in bryological and paleontological studies at his home in Columbus, Ohio.

It was a bright morning in early June when the writer called at the house of Dr. Lesquereux. A few moments of waiting in the parlor were followed by the entrance of a middle-sized man with dark eyes that flashed with mirthfulness when he spoke, and a step so brisk, and hair and beard so free from time-strokes, that the long-cherished patriarchal vision of the botanist's appearance vanished.

"I am happy to make your acquaintance," said the colleague of Agassiz and Guyot, in English, melodious with the accent of France. "My son told me you were coming to see me," he continued, shaking my hand cordially. "Do you speak French? No? So, so. With my bad English and bad hearing"—he smiled, and pressed those ears that had been dead to sound for more than half a century—"I fear we can not carry on a satisfactory conversation," he said, as we drew our chairs to the open window. Then, with glowing eyes and a winning smile on his kindly old face, in response to written queries he modestly told the story of his life.

Leo Lesquereux was born at Fleurier, Neufchâtel, November 18, 1806. His immediate ancestors were French Huguenots. His father was a manufacturer of watch-springs, and, as was the custom of the country, wished his son to follow the same trade. The future botanist's health being delicate, however, his mother desired him to study for the ministry. But the grandeur of his mountain home had already sunk deep into the impressible soul of the youth, and circumstances sealed his preference for another pursuit. Under royal patronage the Academy of Neufchâtel enjoyed special advantages. When the young Swiss crossed its threshold he met in the enthusiastic Guyot a congenial companion. "Guyot and I," said Lesquereux, "were for some years brothers in study, working in common, and often spending our vacations together, either at Guyot's home at Hauterieve or with my parents at Fleurier, and I owe much in life to the good influence of this friendship." When Lesquereux had completed the Academy course he went to Weimar to perfect himself in the German language, preparatory to entering the university at Berlin. To defray his expenses here, he taught French in a young ladies' academy. "They were the happiest days of my life," he said. "My pupils were from the noble families of Weimar. They were well educated, and came to me for conversation. I remained at Weimar for some time. Then love came, and I went back to Switzerland, and I *never* regretted it."

It was at Weimar that the botanist met the young woman who became his wife. She was of humble fortune but of noble family, and in early childhood enjoyed the friendship of Goethe. Her father was a man of learning, with a strong propensity to science. When the young man was about to return to his home, the father, who was setting out in the same direction, invited him to share his carriage. The marriage was agreed upon during this journey. Lesquereux brought his bride to Fleurier, where, in sight of the lofty Alpine peaks, he became engaged in the study of mosses, and later of fossil botany. It was at this period that he became interested in peat, its formation and possible reproduction. The protection of the peat-bogs, the principal fuel of Switzerland, was then a matter of great importance to the Government of Neufchâtel. Lesquereux published some memoirs of his investigations, which attracted the attention of Agassiz, then occupying the chair of Natural History in the Academy of Neufchâtel. He invited the author to visit him for a consultation upon the theories he had set forth. Shortly after this visit—which started a friendship that ceased only with Agassiz's death—the Government of Neufchâtel offered a gold medal for the best popular treatise on the formation and reproduction of peat.

A committee of eight *savants* was appointed to explore the peat deposits of the state, in order to be fully informed of the value of Lesquereux's researches. Professor Agassiz, who was a member of the committee, at first did not agree with his theory, but after the committee had been out a few days—they were two weeks on the field—he accepted it, and became its ardent supporter. "During these days, passed in constant intercourse with the great Agassiz," said Lesquereux, "I became sincerely attached to him; not only on account of his great mind and disposition to consider any subject fully, but because of his goodness of heart, the charm of his conversation, his childlike simplicity, and clearness of thought and expression, even in discussing the most abstruse subjects of science." Lesquereux's memoir was awarded the prize, and gained wide reputation; and it is still quoted as one of the best authorities on the subject. The author, under the patronage of the King of Prussia, subsequently explored the peat-bogs of Northern Europe. In this manner he became master of the botany, physics, chemistry, and geology of those districts, and was led to think that the theory he had formulated might be applied to the coal-seams of our country. To the New World his labors were now transferred, in 1848, when, having become totally deaf in the prime of life, he also found himself deprived of scientific employment at home by the political changes that followed the revolution. It was at this crisis that he came to Boston, where, at the earnest solicitation of that naturalist, he became a member of the household of Agassiz. Here he worked upon the botanical part of Agassiz's "Journey to Lake Superior," until the eve of Christmas, 1848, when, at the invitation of the eminent bryologist, W. S. Sullivant, he went to Columbus, Ohio, and, entering his laboratory, continued there the study of mosses. At the close of the year 1849, under the advice and with the co-operation of Mr. Sullivant, he made a tour of exploration among the mountains of the Southern States, for the collection of plant-specimens, and secured a great variety of plants, which found a ready sale among scientific students. He was particularly successful in the collection of mosses. The preparation of the specimens, their determination and distribution, gave him employment for two years, and resulted in one of the most valuable contributions to American bryology—the "Musci Americani Exsiccati," by W. S. Sullivant and L. Lesquereux. The expense of preparation and publication of this work was defrayed by Mr. Sullivant, who allowed his colleague the benefit of the sales. Using that author's library and herbarium—now the property of Harvard College—for their common studies, Lesquereux lent most valuable assistance to the preparation of Mr. Sullivant's works on the mosses of the Wilkes' South Pacific Exploring Expedition, Whipple's Pacific Railroad Exploration, and the "Icones Muscorum." The publication of Brongniart's "Prodrome," and the commencement of the "Histoire des Végétaux Fossils," in 1828, laid the solid basis upon which the science of paleobotany has been erected. Lesquereux began to write in 1845, and his studies in America have been directed especially in the line of fossil botany. His most valuable researches, beginning in 1850, lay in the study of the coal formations of Ohio, Pennsylvania, Illinois, Kentucky, and Arkansas, and his reports appear in the geological surveys of all these States. Particularly important are his studies of the coal flora of Pennsylvania, published in the report of H. D. Rogers in 1858, together with a "Catalogue of the Fossil Plants which have been named or described from the Coal-Measures of North America." Lesquereux also worked up the coal flora in the second geological survey of Pennsylvania. The fruit of this labor was two volumes of text and an atlas, published in 1880—the most important work on carboniferous plants that has been produced in America. Geological work, especially researches on fossil botany, in connection with the United States Geological Surveys of the Territories, began in 1868 to absorb his attention. He was employed to work up the collections of Dr. F. V. Hayden's surveys of the Territories, and important papers on the subject appeared in the annual reports of the surveys from 1870 to 1874 inclusive. Lesquereux was frequently called to Cambridge to determine the specimens of fossil plants in Professor Agassiz's museum, where he was a guest in the naturalist's household for weeks and months at a time, and his attachment to him grew very strong.

Lesquereux, during his long and industrious life, has contributed twelve important works to the natural history of North America, besides a large number of memoirs on divers subjects, amounting in all to about fifty publications. He is a member or correspondent of more than twenty scientific societies of Europe and America, and was the first elected member of the National Academy of Sciences. The characteristic works of the most eminent scientific writers of the age comprise his library: Brongniart, who laid the foundation of paleobotany; Göppert, who built its superstructure; Schimper, Heer, Dawson, Ettingshausen, Newberry, the Marquis Gaston de Saporta, together with Grande Eury and Renault, who thoroughly studied the carboniferous flora of France; Williamson, who mastered that of England; Nathorst, who opened up the subterranean floral treasures of Sweden; Engelhardt, Hosius, Under Marck and Schenk, who investigated without exhausting the rich plant-beds of Germany—all are numbered among Lesquereux's friends and correspondents.

The fraternal bond that binds the scientific world is almost indissoluble. When asked if his long and intimate associations with so many illustrious minds had not stored his memory with anecdote and reminiscence, Lesquereux responded: "The science-students' life is absorbed with grave and serious truths; they are naturally serious men. My associations have been almost entirely of a scientific nature. My deafness cut me off from everything that lay outside of science. I have lived with Nature, the rocks, the trees, the flowers. They know em, I know them. All outside are dead to me."

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8. Paleontological Report. Pennsylvania Geological Report. 1857.
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16. Catalogue of California Mosses. Transactions of American Philosophical Society, vol. xiii. 1864.
17. On Tertiary Fossil Plants of Mississippi. Transactions of American Philosophical Society. vol. xiii. 1864.
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17. On Pacific Coast Mosses in California. Academy of Sciences. 1868.
18. Musci Exsiccati, first edition. In association with W. S. Sullivant. 1856.
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22. Report to Hayden. United States Geological and Geographical Survey of the Territories. 1870.
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28. Review of the Fossil Flora of North America. (Republished, with corrections, in the Penn Monthly.) 1875.
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40. The Coal Flora (Atlas). Second Pennsylvania Geological Survey. 1879–1884.
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42. Manual of the American Mosses. With Collaboration of Thomas P. James. 1884.
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45. Vegetable Origin of Coal. Report of Geological Survey of Pennsylvania. 1885.
46. Divers Questions concerning Coal. Silliman's Journal. 1860.
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On Some Fossil Plants of the Recent Formations. 1859.
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CORRESPONDENCE.

MORE ABOUT THE "JOINT-SNAKE."

Editor Popular Science Monthly:

SIR: In the January number of the "Monthly" one of your correspondents enters the list as a champion of the *joint-snake tradition*, and adds the details of a personal encounter with the problematic ophidian. He informs us that he has preserved the memory of the very spot where he saw the disjointed fragments of the much controverted reptile. It is a pity that he did not also preserve a few of those fragments. When the evidence of the controversy was sifted in the columns of "Home and Farm," a year ago, Professor C. H. Hunter, of Louisville, offered a liberal reward for a specimen *joint-snake*, or any two readjustable sections of that complex entity. Similar inducements have been repeatedly offered by Dr. Baird, by the editors of the "American Naturalist," by Professor McKnight, of St. Louis, Missouri, and by several patrons of the Smithsonian Institution. Yet the one *visible* link in the alleged chain of evidence is still missing. The museums of the civilized world do not yet boast a specimen of a joint-snake or any two reconstructible sections of its organism. One of the correspondents of "Home and Farm" suggested that people are naturally averse to handling reptiles, even of the more harmless varieties. They must be at least equally averse to handling the less harmless varieties, and such things as hairy, venomous spiders. Yet it would be no overestimate to say that the museums of the United States alone contain a thousand tarantulas, and at least twice as many rattlesnakes and "spreading adders." If we are to go by hearsay evidence, we would have to believe in vampires and fairies, as well as dragons and sea-serpents. The vampire-stories of the lower Danube have been confirmed by the testimony of a host of witnesses, many of them respectable persons of more than average intelligence. The same held doubtlessly good of the witchcraft-stories, accepted by the most enlightened jurists of the middle ages, on the detailed and positive testimony of eye-witnesses. A fair plurality of those witnesses may have intended nothing like willful misrepresentation. But the belief prevailed, and biased their faculties of observation, as well as their fancy. A direct refutation of hearsay evidence is, of course, impossible, and I hold that the burden of the proof rests exclusively with its defenders. Direct proofs we have none; the indirect proofs, i. e., the entire and persistent absence of all positive evidence, as well as the glaring anomaly of the alleged portent, point all the one way. In the present stage of the controversy an infinite preponderance of probability is therefore clearly against the exponents of the tradition.

Yours, very respectfully,
JAMES T. BECKER.

LUDLOW, KENTUCKY, *February* 3, 1887.

AN EXPLANATION OF THE "JOINT-SNAKE."

Editor Popular Science Monthly:

SIR: Whatever some of your contributors may say to the contrary, there certainly is a reptile resembling a snake, inhabiting the western part of the United States, the tail of which flies to pieces on very slight provocation. It is not, however, a snake, as some of them suppose, but a limbless lizard of the genus *Ophisaurus*. I have seen hundreds of them in Kansas near Fort Riley and farther west, and have sent many specimens to the Academy of the Natural Sciences of Philadelphia and to the Smithsonian Institution in Washington. This lacertilian is a very beautiful animal, varying in length from ten to fourteen inches or more, and in diameter at its largest segment from three-fourths of an inch to an inch and a half. It is perfectly harmless, and when struck or captured sheds its tail sometimes in several pieces, each of which continues to wriggle for some time afterward. It is, perhaps, scarcely necessary to say that these several segments do not start out on voyages of discovery for each other in order to reunite with their parent. The animal has, however, the power of reproducing the lost part, as have other lizards. The name of "glass-snake" is that by which this reptile is popularly known. Glass-snakes are common in other parts of the world. The *Pseudopus Pallasii* is found in Hungary, Bulgaria, Turkey, and neighboring countries. In general appearance it resembles a snake. The fore-limbs are entirely absent, and the hind-limbs are rudimentary, as they are in certain true ophidia. Lizards without legs are also very abundant in Australia.

Other lizards, besides the glass-snakes, lose their tails with great ease, and some of them, like the geckos, throw off this appendage spontaneously as a means of protection, doubtless hoping thereby to create a diversion of the enemy toward the wriggling fragment, while the owner makes good its escape. The *Ophisaurus ventralis* of Kansas and other Western States has no external limbs; there are, however, rudimentary hind-limbs under the skin, very similar in general appearance to those found in the black-snake (*Coluber constrictor*). Stories of the quivering fragments of its tail coming together again after being detached from the body were common enough among the soldiers and settlers, but I am able to state of my own knowledge (though it seems to be a waste of words to do so) that they are not endowed with sufficient perceptive and volitional power to accomplish such an act. They die in a few hours, and are reproduced by the animal in a few months. The *Ophisaurus* is perfectly harmless, and is readily tamed so as to become a pet.

WILLIAM A. HAMMOND.

NEW YORK, *March* 1, 1887.

EDITOR'S TABLE.

SCIENCE AND STATESMANSHIP.

IN the January number of the "Contemporary Review," Madame Adam has an article entitled "Science in Politics," the main contention of which appears to be that science and politics make a very bad mixture. The proof of this position she finds in the evil influence exerted, as she believes, by the late M. Paul Bert on contemporary French politics. M. Bert, she avers, was the ruin of Gambetta by turning him aside from a broad, sympathetic way of treating public questions into a narrow and abstract way of treating them. The *savant* applied himself to political questions in the same spirit in which he applied himself to questions of physiology; and was prepared to act upon the results obtained with as little hesitation as if it were a mere matter of carrying through some laboratory experiment. In fact, he was just as ready to vivisect the nation with a new school law as to vivisect a cat in the ordinary fashion. So runs the indictment against M. Bert; and because M. Bert, the scientist, was so rash an innovator in politics, we are asked to learn the lesson that the more science is kept out of politics the better. Well, Madame Adam is a very clever woman, and what she says about M. Bert may be all true; but we do not quite see our way to an acceptance of the conclusions she offers us. Science is something more than physiology: a man may be a good physiologist, and yet outside of his special study may have anything but a scientific mind. What is wanted for political action is science in its most comprehensive sense; and, other things being equal, the more of true science a statesman possesses, the better fitted, we fully believe, he will be for his position. The statesman, of course, needs to know men, and to know them, not as subjects for the operating-table, but as living, moving units of the social organism. But this knowledge properly co-ordinated is scientific knowledge. The scientific statesman is not swayed by every impulse of the hour; he knows something of human history; and he knows how short-lived many movements are, and how infallibly communities will in the long run obey the general laws of their evolution. At the same time he makes allowance for the strength of many feelings that perhaps he does not himself share. He may be very free from prejudice himself; but he knows how large and how necessary a part prejudice plays in human affairs, and makes allowances for it accordingly. To a man who had got beyond physiology and physiological methods the knowledge he had acquired of that science would often be of special value for the understanding of political problems. The problem of problems in politics is indeed to establish a sociological balance of functions analogous to that physiological balance which is measurably attained in the healthy human body. We want to avoid congestion on the one hand and depletion on the other. We want neither overnutrition nor innutrition. We want brain-direction, but we want spontaneous activity in local centers. We want a proper division of labor, a proper specialization of function. We want a stable equilibrium of society such as results from free contact with natural influences and conditions. To say that a knowledge of the normal and pathological conditions of the human body would be of no advantage—would be even a drawback—for the understanding of social phenomena and the guidance of social action, seems to us a most unreasonable position. We should say that it would be a great and signal advantage provided only—as we have already hinted—that the physiologist knew enough to recognize that social facts call for somewhat wider canons of interpretation than physiological ones.

But there is positively no science that will not bring its own quota of aid to statesmanship. Chemistry, with its definite laws of combination, its resemblances concealed under differences and differences concealed under resemblances, throws many a gleam of light on the phenomena of human action. So with physics, so even with mathematics. But when we speak of science aiding statesmanship, be it understood that we mean statesmanship, and not merely the art of the political manager. The statesman can afford to have a mind widened and enriched by every variety of knowledge. Why? Because it is his concern to know the truth about everything, in order that he may consult for the general good to the best possible advantage; because he wishes to mark out such lines for political activity as run parallel with those that Nature has traced in bringing man up to the political stage; because he wishes to build on Nature's foundations, and so help to establish a natural and durable order of things in the political world. The party manager, on the other hand, has nothing to do with these things: he wants to organize victory for his party, and for that purpose he only requires the aid of a very special science—the science of catching votes. At present there is not much science in our politics. Madame Adam need not tremble lest accomplished physiologists should disturb the American system with methods borrowed from the laboratory. We keep all such people at a safe distance, and pay honor only to the manipulator of the caucus and the primaries. But when politics comes to be recognized as the science of good government instead of as the science of *getting hold of the government*, the need for statesmanship will begin to be felt; and with the demand for statesmanship will come a recognition of the fact that the highest and widest knowledge can nowhere be more profitably or honorably employed than in the service of the community.

THE GROWTH OF INDUSTRIALISM.

Threatenings of war continue to reach us from abroad, and appear to grow more serious with each succeeding repetition. They are often accompanied, it is true, by expressions of a desire for peace, emanating in some cases from those highest in authority; but these seem to be little more than the shallowest pretense, for they are belied by the systematic and unremitting preparations for conflict so generally apparent. Yet these very preparations are in turn impudently justified as tending to the preservation of peace and good-will. Taking advantage of the excitement and solicitude that the prospect of a great European war is calculated to arouse, the spendthrift politicians of our own country are vigorously urging their schemes for the multiplication and improvement of our coast defenses and the increase of our naval armament. These measures are also claimed to be in the interest of peace, when, in reality, if carried into effect, their immediate result will be an enormous expenditure of public money, and afterward their presence will be more likely to provoke than to avert a collision. The nation equipped for war is like the bully with his revolver—always ready for a row, and not likely to miss the chance when an opportunity occurs.

Unfortunately, there seems to be enough of this belligerent and barbarous spirit left, especially in the Old World, to keep up a constant turmoil, or at least to maintain a state of perpetual apprehension, which tends to exert a paralyzing effect upon all forms of industrial effort. But, bad as the outlook at present appears, there is much cause for satisfaction on the part of the friends of industrialism in the growth and extension, under the favoring influence of science, of the arts which make for peace and right living; and it is not a little encouraging that there is already apparent a decided tendency to abandon the strifes of war, and adopt in their stead the more generous rivalries incident to a process of industrial development.

During the last quarter of a century a great impulse has been given in many states to manufacturing interests, the improvement and perfection of working methods, and the competition for excellence in industrial products; and, even in some of the nations whose warlike attitude has given alarm, the earnestness of the people in this direction is already comparable with and promises ultimately to suppress the belligerent disposition of their rulers. Thus it happens that the merchants of Germany are crowding the English out of the markets which they thought their permanent possession, by being able to offer to buyers more desirable bargains. The reason of this is that, while those who supposed they held a monopoly of these markets have been content to rest at a certain point of excellence in manufacture, or have even been careless about the matter, their rivals have persistently sought to improve the quality and the methods of production, and to adapt their goods to the exact taste of their customers; and, apace with this, have developed systems of thorough training, in general and special schools, of their artisan classes in all branches of manufacture, and in the numerous applications of science to the arts.

It is thus becoming recognized that excellence in technical industries and the special training of artisan youth are quite as important for the prosperity and security of the nation as a firm military position; and earnest efforts are making in this country and in England to put in operation means by which these may be attained. It has been proposed in England to honor the jubilee of the Queen's reign by founding an Imperial Institute, the purpose of which shall be to advance the knowledge and practical skill of the productive classes of the empire. The exact shape which the scheme shall assume has not yet been determined, and has hardly been conceived. Professor Huxley, who warmly commended it at a public meeting, would have in the Institute, as he has said in a note subsequently written, "something which should play the same part in regard to the advancement of industrial knowledge as has been played in regard to science and learning in general, in these realms, by the Royal Society and the universities." In his conception of the scheme as he commended it, he pictured the Imperial Institute to himself, he says—

As a house of call for all those who are concerned in the advancement of industry; as a place in which the home-keeping industrial could find out all he wants to know about colonial industry and the colonist about home industry; as a sort of neutral ground in which the capitalist and the artisan would be equally welcome; as a center of intercommunication in which they might enter into friendly discussion of the problems at issue between them, and, perchance, arrive at a friendly solution of them.

I imagined it a place in which the fullest stores of industrial knowledge would be made accessible to the public; in which the higher questions of commerce and industry would be systematically studied and elucidated; and where, as in an industrial university, the whole technical education of the country might find its center and crown.

If I earnestly desire to see such an institution created, it is not because I think that or anything else will put an end to pauperism and want—as somebody has absurdly suggested—but because I believe it will supply a foundation for that scientific organization of our industries which the changed conditions of the times render indispensable to their prosperity.

I do not think I am far wrong in assuming that we are entering, indeed have already entered, upon the most serious struggle for existence to which this country has ever been committed. The latter years of the century promise to see us embarked in an industrial war of far more serious import than the military wars of its opening years. On the East, the most systematically instructed and best-informed people in Europe are our competitors; on the West, an energetic offshoot of our own stock, grown bigger than its parent, enters upon the struggle possessed of natural resources to which we can make no pretension and with every prospect of soon possessing that cheap labor by which they may be effectually utilized.

Many circumstances tend to justify the hope that we may hold our own if we are careful to "organize victory." But, to those who reflect seriously on the prospects of the population of Lancashire and Yorkshire—should the time ever arrive when the goods which are produced by their labor and their skill are to be had cheaper elsewhere—to those who remember the cotton famine, and reflect how much worse a customer famine would be, the situation appears very grave.

Such an institution as Professor Huxley here outlines, founded under the auspices which surround this enterprise, would undoubtedly give an immense impetus to efforts for the elevation of industrial art; and its establishment, if effected, will mark an epoch in the history of the practical applications of science.

LITERARY NOTICES.

The Geographical and Geological Distribution of Animals. By Professor Angelo Heilprin. "International Scientific Series." Vol. LVII. D. Appleton & Co. Pp. 435. Price, $2.

This volume sustains the high character of the International Scientific Series, and is a timely one, as the need of a compact work on this fascinating study has long been recognized. Wallace's larger work, in two volumes, while graphic in its method and full of interesting reading, is somewhat antiquated in its classification, a fault from which this book is not quite free.

The reader will find brought together a remarkable array of facts from various authors bearing upon the many questions involved in the subject. A vivid sketch is given of the apparently startling contradictions in the distribution of animals, the well-known case of faunal separation between the Islands of Bali and Lombok being cited among others. The author then says: "Mysterious as these various phenomena of distribution may appear, they yet have all their logical explanation. A quarter of a century ago, when the doctrine of independent creation still held sway over the minds of most naturalists, and when the organic universe was reflected in the eye of the investigator as an incongruous agglomeration of disjointed parts, there was, indeed, no necessity for specially accounting for the facts, since they were conceived to be such by reason of a previous ordination. Now, however, when the full value of the evolutionary process is recognized, and animate nature has come to be looked upon as a concrete whole, bearing special relations to its numberless parts, each individual fact seeks its own explanation, which explanation must of necessity stand in direct harmony with some previously observed fact. When, therefore, we seek to unravel the tangle of zoögeography and to harmonize its apparent incongruities, we must at the outset admit that distribution, such as it is, is the outcome of definite interacting laws—laws which stand in relation to each other as absolutely as they do in any other field of action—and not a hap-hazard disposition, as some would lead us to suppose, setting all inquiry at defiance."

Among the many subjects treated of are relations of past faunas; origination of faunas; areas of specific, generic, family, and ordinal distribution; conditions effecting distribution; migrations of animals; dispersions; zoölogical regions accompanied by a colored outline-map; distribution of marine life; nature of marine faunas, such as deep-sea, oceanic, pelagic, littoral; succession of life; faunas of different geological periods; appearance and disappearance of species, reappearance, extinction, and other subjects dealt with from geological evidence. Here the author enters into interesting discussions in regard to possible reappearance of species, quoting opinions and statements from various authors, and leaning somewhat as to the possibility of a species evolving again from the parent or parallel stock. In reading these pages, one is more fully convinced than ever that such apparently inexplicable occurences of identical species in beds widely removed vertically are more rationally explained by the assumption of the very great imperfection of the geological record. As an evidence of this, consider the fact that over two hundred thousand species of insects have been described as living to-day. Now this class of creatures has been in existence since the Devonian, and probably as numerous in species since the Mesozoic as at the present day, and yet the number of fossil insects described from every geological horizon to the present would not exceed in number the species of the smallest order living at present. A species of Lingula, which is found in a few localities on the southern coast of the United States, if fossilized would very closely resemble certain forms in the Silurian. One might scan the Tertiary beds in the Southern States without finding a trace of this species, and yet an elevation of the coast-line of North Carolina might show this ancient worm in great numbers when the deposits below reveal no trace of it. This might appear to a future geologist like a re-evolution of this species, whereas, judging from what we know of the geographical limitations of certain groups, it can only be interpreted as the preservation of colonies under favorable conditions.

Globigerina still survives, because the abysses of the deep sea probably remain in the same physical conditions as regards temperature, pressure, light, etc., as they did in the Cretaceous, and thus we have this creature and other cretaceous forms persisting to the present day.

We can heartily commend this book as a convenient and compact treatise on a great and voluminous subject.

Physiological Botany. An Abridgment of the Student's Guide to Structural Morphological and Physiological Botany. By Robert Bentley, F. L. S. Prepared as a sequel to "Descriptive Botany," by Eliza A. Youmans, author of "First Book of Botany," editor of "Henslow's Botanical Charts." New York: D. Appleton & Co. 1887. Pp. 292. Price, $1.40.

The author of this work, Dr. Robert Bentley, is an eminent English botanist, who has had more than thirty years of practical experience as a teacher, and whose various text-books hold a first place in his own country. The present treatise is a model of clear, concise, and accurate statement, giving a complete popular view of the minute structures, the functions, and the development of the various organs of plants. Great pains have been taken by Professor Bentley to bring the different subjects treated of down to the present state of science, and much care has evidently been exercised in condensing the numerous details in each department and arranging them in the best manner for the pupil.

As physiological botany is the same in every part of the globe, and might exist in its fullness if there were only one species of plant in existence, the fact that this work is by an English author has no bearing upon its use in this country. The "Descriptive Botany," with its contained Flora, published two years ago in this series, and to which this is a sequel, covers all that portion of botanical science which has local bearings. In the introduction to that work, after explaining and enforcing the reasons for an early beginning of the study of plants by direct observation, it is recognized that physiological botany may be pursued with profit by ordinary school methods, and the publication of the present manual was accordingly promised; and it completes the exposition of botanical science in Appletons' series of science text-books.

The Origin of the Fittest. Essays on Evolution. By E. D. Cope. New York: D. Appleton & Co. Pp. 467.

This volume includes twenty-one essays which represent the reflections that suggested themselves to the author while he was engaged in special zoölogical and paleontological studies. These studies related particularly to the vertebrates, but they impressed the conviction that the conclusions derived from them were also applicable to invertebrate animals and plants. The law of natural selection of Wallace and Darwin is regarded by Professor Cope as only restrictive, directive, conservative, or destructive of something already created. It includes no active or progressive principle, but "must first wait for the development of variation, and then, after securing the survival of the best, wait again for the best to project its own variations for selection. In the question as to whether the latter are any better or worse than the characters of the parent, natural selection in no wise concerns itself." The expression, "survival of the fittest," with which Spencer epitomized this law, is pronounced "neat," and "no doubt covers the case, but it leaves the origin of the fittest entirely untouched." It is proposed, then, to seek for the originative laws by which the materials whence the selection is made are furnished—"in other words, for the causes of the origin of the fittest." The laws which have regulated the successive creations, as the author attempts to define them in his essay on the "Origin of Genera," appear to him to have been of two kinds: the first, that which has impelled matter to produce numberless ultimate types from common origins; and, second, that which expresses the mode or manner in which this first law has executed its course, from its beginning to its determined end. The origin of genera is assumed to be a more distinct subject from the origin of species than has been supposed. A descent with modification involves continuous series of organic types through one or many geologic ages, and the coexistence of such parts of such various series at one time as the law of mutual adaptation may permit. These series, as now found, are of two kinds—the uninterrupted line of specific, and the same uninterrupted line of generic characters. These are independent of each other, and have, as it appears to the author, been developed *pari passu*, so that he conceives it "highly probable that the same specific form has existed through a succession of genera, and perhaps in different epochs of geologic time"; or, as it is otherwise expressed, species may be transferred from one genus to another without losing their specific characters, and genera from one order to another without losing their generic characters." These explanations may help to make more clear the bearing of what may be regarded as the leading doctrines of Professor Cope's theory, which are, in brief, that the development of new characters has been accomplished by an acceleration or retardation in the growth of the parts changed; that an exact parallelism exists between the adult of one individual or set of individuals, and a transitional stage of one or more other individuals—to be distinguished from the inexact parallelism of Von Baer, a law which expresses the origin of genera and higher groups because they can only be distinguished by single characters when all their representatives come to be known (that is, that upon a view of all the individuals the transitional differences are so gradual that hard and fast lines of distinction are obliterated); that genera and various other groups have descended, not from a single generalized genus, etc., of the same group, but from corresponding genera of one or more other groups—the doctrine of homologous groups; and that these homologous groups belong to different geological periods and different geographical areas, and are related to each other in a successional way like the epochs of geological time. To these are added the law of repetitive action, by which the structures of animals are shown to have originated from simple repetitions of identical elements; and the existence of a special force exhibiting itself in the growth of organic beings, called growth-force, or bathmism, the location of which at certain parts of the organism, indicating abstraction from other points, determines the direction of development. The location of the growth-force is accomplished by use or effort, which is exerted so as to modify the environment, and is modified by it. The location of this energy, to produce the change of evolution, is due to an influence called "grade-influence," which is, further, an expression of the intelligence of the animal, adapting its possessor to the environment by an "intelligent selection." Inheritance is a transmission of this form of energy. The part performed by intelligence in evolution is correlated with the fact deduced from the observation of the birds and mammals, that all animals are educated by "the logic of events," that their intelligence, impressed by changed circumstances, can accommodate itself more or less to them, and that there is nothing in this part of their being opposed to the principle of "descent with modification." The genus *homo*, according to the author's conclusions, "has been developed by the modification of some pre-existent genus. All his traits which are merely functional have, as a consequence, been produced during the process. Those traits which are not functional, but spiritual, are of course amenable to a different class of laws, which belong to the province of religion." The evolution of moral qualities may be related with the reproductive instinct, from which the social affections are developed. The struggle for existence among men ranges all the way from a rivalry of physical force to a rivalry for the possession of human esteem and affection. "The ultimate prosperity of the just, assured and foretold by prophets and poets, is but a forecast of the doctrine of the survival of the fittest. The unjust are sooner or later eliminated by men from their society, either by death, seclusion, or ostracism." But lines of men in whom the sympathetic and generous qualities predominate over the self-preservative, are doomed to extinction. Hence, evolution can produce no higher development of the race than an equivalency of these two classes of forces.

The matter of the volume is arranged in four parts, or series of essays: First, appear the papers on "General Evolution," in which the general principles of the author's theory are aid down or foreshadowed. Following this part come, s ccessively, papers on the "Structural Evidences of Evolution," on "Mechanical Evolution," and on "Metaphysical Evolution." In the concluding paper, the "Origin of the Will" is discussed.

Our Arctic Province. Alaska, and the Seal Islands. By Henry W. Elliott. New York: Charles Scribner's Sons. Pp. 465. Price, $4.50.

Mr. Elliott has given a most attractive volume, full of general and of scientific interest. The scientific matters are presented so as to be popular reading, and that which may be classed as of general interest is very far from not being of scientific merit and value. It is impossible to give, in an ordinary book notice, a summary of a work embodying so great a variety of matter; and we can not, perhaps, make a more comprehensive characterization of its contents than to say that it is devoted to the description and illustration of Alaska and all that pertains to it. First we have the history of the discovery of the country, its occupation by the Russians, and its transfer to the United States. This is followed by an account of the features of the Sitkan region, and a description of the aboriginal life of the Sitkans. Accounts are given of "The Alpine Zone of Mount St. Elias," with its superb and lofty peaks seen one hundred and thirty-five miles away, and including Mount Wrangel, the highest mountain in North America; of the warm springs near Sitka, of the forbidding character of the coast of the mountain-region, and the grand but gloomy scenery of Prince William Sound. Succeeding chapters are devoted to "Cook's Inlet and its People," "The Great Island of Kodiak," and "The Great Aleutian Chain," which stretches so far to the west as to make San Francisco a half-way city in crossing our country. Chapters are devoted to "The Quest of the Otter," "The Wonderful Seal Islands," and the management and methods of the seal industry. Other peculiar animals to receive due notice are the Alaska sea-lion, the moose, walrus, and polar bear. Far removed in space and character from the Sitka region and the Aleutian Islands are the Innuits, or people of the Esquimo race, who furnish material for a chapter of distinct interest; and the valley of the great Yukon River, and "The Great Northern Wastes," are the subjects of another chapter of equally distinct interest. The graphic descriptions are heightened by pictures of scenery, human life, and occupations, and the constructions of the natives. "How differently," says the author, "a number of us are impressed in the viewing of any one subject, by which observation we utterly fail to agree as to its character and worth!" The remark is pertinently illustrated in this book. The general impression has been that there is not much of value or interest in Alaska. The impression is inevitable, after reading "Our Arctic Province," either that Alaska is one of the most interesting regions of the earth, or that the author is one of those rarely gifted observers who know how to seek out and find matters of interest and beauty where ordinary men would only grope blindly.

A Nomenclature of Colors for Naturalists, and Compendium of Useful Knowledge for Ornithologists. By Robert Ridgway. Boston: Little, Brown & Co. Pp. 129, with Seventeen Plates.

The preparation of this book has been instigated by the author's feeling of a want while pursuing his own studies as an ornithologist. He could find, on one side, no authoritative nomenclature of colors, and, on the other hand, no compendious dictionary of technical terms used in ornithology, with specific references to the exact parts of the bird to which they were intended to apply. In both cases, approximate identification was the most that could be expected. The identification of color-tints offers peculiar difficulties. The variations are almost infinite, and are subject to modifications by the changing aspects and incidence of the light. Very few natural colors or artificial ones are permanent; most of them are liable to change with time or under chemical influences. The author, in treating of those points, gives a chapter to the discussion of the "Principles of Color," in which he lays down ten color-elements, formed from the primary colors, which in their binary combinations give ninety more or less distinct colors; and these are susceptible of great diversites of intershadings. Seventeen pages are occupied with a "Comparative Vocabulary of Colors," giving equivalent names of colors and shades in six languages. A series of plates gives some two hundred of these colors in actual chromatic illustrations composed out of fine artists' pigments selected from the shops of the best makers as those most likely to be true and permanent in tone. The bibliography gives the names of eight books consulted, in the order of their importance. The second part of the book (the "Ornithologist's Compendium") contains a glossary of technical terms used in descriptive ornithology, and comparative tables of millimetres and English inches and decimals. Six plates in outline are intended to show and localize the parts of the bird and the forms of feathers and eggs.

A Trip around the World. By George Moerlein. Cincinnati: M. & R. Burgheim. Pp. 205, with Chromolithographic Plates.

This work is attractive on account of its illustrations. The author made the journey which he describes in 1884–'85, for pleasure and recreation, with two companions, who went by his invitation upon a similar errand. The journey included Japan, China, India, and Ceylon, and other Eastern countries, and Europe. The account here given is confined almost entirely to the far East, because it was there the party sojourned the longest, and had the opportunity of viewing the many (to them) strange sights and scenes. A straightforward narrative of what they saw and heard is given, without pretense to learning or literary elaboration, with historical and statistical information obtained from the most reliable sources. The illustrations represent various phases of life and scenery in the East, and are of a very satisfactory character. They were carefully chosen, we are told, from a collection of more than eight hundred original pictures collected during the journey, and are colored true to nature.

Commercial Organic Analysis. By Alfred H. Allen, F. I. C., F. C. S. Second edition, revised and enlarged. Vol. II. Philadelphia: P. Blakiston, Son & Co. Pp. 583. Price, $5.

The worth of this originally valuable treatise has been vastly increased by its revision and enlargement. The first edition comprised two volumes, but the work has been so much extended that it was found necessary to issue this edition in three. The first volume was noticed in the "Monthly" for November, 1885. The second volume, which is now at hand, is devoted to fixed oils and fats, hydrocarbons, phenols, etc. Somewhat more than half of the volume is occupied by the first of these divisions. The physical characters of the oils are described first, and then the reactions based on the chemical properties. These sections are succeeded by a tabular classification of the oils based on a joint consideration of their origin, physical characters, and chemical constitution. Then follow methods of examining fatty oils and waxes for foreign matters and of identifying them, and after that come special methods of assaying some thirty of the principal commercial fixed oils. The next section, on the examination of lubricating oils, and that on mineral lubricating oils, which comes later, contain much matter of interest to the mechanical engineer as well as to the chemist. Appended to this division are descriptions of the chief saponification products of fixed oils—the higher fatty acids, soaps, glycerin, etc. The author has given much personal attention to methods of determining the density of fixed oils, for this property, being largely dependent on the constitution of the oils, is a more or less important means of identification. He especially recommends the Archimedean or plummet method of taking specific gravities, using Westphal's hydrostatic balance. In discriminating between butter and its imitations, he has found the specific gravity test valuable. He also recommends for examining butters the determination of the volatile fatty acids by Reichert's distillation process.

The temperature at which a mixture of the melted fat with glacial acetic acid becomes turbid on cooling is deemed by him another important indication, but he says that further experience is necessary before the trustworthiness of this test can be considered fully established.

The accurate determination of glycerin in a complex mixture is a problem which the author does not consider has received a satisfactory solution under all circumstances. After giving several methods of isolating glycerin in an approximately pure state, available in various circumstances, he proceeds to describe certain processes based on the chemical reactions of glycerin. A method originally suggested by J. A Wanklyn, has been very fully investigated in the author's laboratory, and proved to give very accurate results under certain conditions. This method is based on the oxidation of the glycerin by treatment with permanganate in presence of excess of caustic alkali, whereby it is converted into oxalic acid, carbon dioxide, and water. The excess of permanganate is then destroyed by a sulphite, the filtrate acidulated with acetic acid, and the oxalate determined as a calcium salt. In the presence of foreign bodies yielding oxalic acid on oxidation, the process is evidently useless.

In the second division, after some general description of the hydrocarbons, the tars of various origins are considered, and then the bitumens. The important commercial products derived from petroleum and shale are duly described, after which are taken up the terpenes, benzene and its homologues, naphthalene and anthracene. The properties and methods of assay of monohydric and dihydric phenols are given in the concluding division. The chapters on the aromatic acids and tannins have been deferred to the third volume, which will contain also chapters on coloring-matters, cyanogen compounds, organic bases, albuminoids, etc.

The Swiss Cross: A Monthly Magazine of the Agassiz Association. Vol. I, Nos. 1 and 2, January and February, 1887. Edited by Harlan H. Ballard. New York: N. D. Hodges, 47 Lafayette Place. Pp. 40 each. Price, 15 cents a number, $1.50 a year.

The Agassiz Association is an organization for the practical study of Nature, which originated some ten years ago, under an impulse given by the editor of "The Swiss Cross," in the Lenox High-School, Massachusetts. Other societies joined the original society to co-operate with it; and these affiliated local societies or "chapters" have increased till they number nine hundred and eighty-four, having from four to one hundred and twenty members each, of all ages from four years to eighty-four years, distributed in nearly all the States and Territories, and in Canada, England, Ireland, Scotland, Chili, Japan, and Persia. The chapters are of four different sorts: family chapters, composed of the parents and children of a single family; chapters in schools in which teachers and pupils may join; chapters organized and conducted entirely by young persons; and chapters of adults. The chapters of single States are brought into harmonious action through confederations, which are called Associations, of which the ones most prominent at present are the Philadelphia Assembly and the State Assembly of Iowa. Until this year the Agassiz Association has found in the "St. Nicholas" a medium of communication between its branches and members and with the public; but finding it needed more space than that journal could afford, it was determined to establish a special organ of its own, and "The Swiss Cross" is the result. The opening number is adorned with a full-page portrait of Professor Agassiz. The editor gives a history of the Agassiz Association, from which we derive the facts we have related; and then the real work of the magazine begins. This consists in the publication of papers in natural history, science, experiment, and observation, contributed by members of the Association or other writers; of a "Children's Hour" (in large type); of miscellaneous matter; and of "Reports from Chapters." With these regular features, the second number gives a sketch and portrait of the late Isaac Lea, "the Nestor of American naturalists." The editor has plans for correspondence schools and for association tables at the biological laboratories, some of which are already begun.

Ham-Mishkan, the Wonderful Tent. By the Rev. D. A. Randall, D. D. Cincinnati: Robert Clarke & Co. Pp. 420.

This book is described as "an account of the structure, signification, and spiritual lessons of the Mosaic Tabernacle erected in the Wilderness of Sinai." Its design is to give as clear and intelligent a statement as is possible of the literal structure of the tabernacle, and in connection with that to present the spiritual lessons the different parts of the building and its furniture suggest or are designed to teach. The author hopes also that the effect of his work may be to promote the development of the religious faculty of his readers. To make the account more life-like, it is cast in the shape of a narrative of a journey through the wilderness—which the author actually made—and of conversations among the scenes associated with the tabernacle. The account is preceded by a biography of the author, with a portrait.

Geological History of Lake Lahontan, a Quaternary Lake of Northwestern Nevada. By Israel Cook Russell. Washington: Government Printing-Office. Pp. 228.

The explorations reported in this volume are a continuation of the "Quaternary Geology of the Great Basin," begun by Mr. G. K. Gilbert when the present geological survey was organized, and have been carried out by the author and his assistants under Mr. Gilbert's direction. The theory of the work is based upon the conclusion to which the geological evidence points, that the valleys of the Great Basin were at one time—which is determined to have been in the Quaternary period—occupied by an extensive series of lakes, of which those to which the names of Lahontan (after Baron La Hontan, one of the early explorers of the head-waters of the Mississippi) and Bonneville have been given. Lake Lahontan filled a valley along the western border of the Great Basin at the base of the Sierra Nevada; Lake Bonneville occupied a corresponding position on the east side of the Great Basin, at the foot of the Wahsatch Mountains. The former was mostly within the limits of the present State of Nevada, the latter in Utah. Lake Bonneville covered 19,750 square miles, and was 1,000 feet in its greatest depth; Lake Lahontan covered 8,422 square miles, and had an extreme depth, where Pyramid Lake now is, of 886 feet. Lake Bonneville overflowed northward; Lake Lahontan did not overflow. Both lakes had two eras of high water, separated by a period of desiccation. As Lake Lahontan did not overflow, it became the receptacle for all the mineral matter supplied by tributary streams and springs; of which that in suspension was deposited as lacustral sediments, and that in solution as calcareous tufa, or appeared as desiccation products after the lake evaporated. The present lakes of the basin are of comparatively recent date, and are nearly fresh, for the reason that the salts deposited when the Quaternary lakes evaporated were buried or absorbed by the underlying clays and marls. Mr. Russell's monograph is an attempt to study out the history of Lake Lahontan, so far as the details of it can be deduced from the geological evidences. It considers the "Physiography of the Lahontan Basin," the physical and chemical and life (animals and plants) history of the lake; the climate of the Quaternary period; the geological age of the lake; and the "Post-Lahontan Orographic Movement."

The Conflict of East and West in Egypt. By John Eliot Bowen, Ph. D. New York: G. P. Putnam's Sons. Pp. 204. Price, $1.25.

This essay was prepared originally as a dissertation preparatory to receiving the degree of Doctor of Philosophy from Columbia College. The matter of it is of public interest, and, in the shaping which the author has given it, is presented in a form to make accessible to the public and to inform it concerning a subject respecting which its present knowledge is rather vague. The subject concerns the condition of affairs in Egypt, and how they came to be in that condition, together with the relations of the powers to the questions at issue. Of these matters, Mr. Bowen gives a concise, intelligible account, beginning with the inception of the Suez Canal enterprise in 1854, and following the events and negotiations through the reigns of Said, Ismail, and Tewfik. It presents M. de Lesseps's struggles to get the Suez Canal under way and construct it, and England's efforts to balk the work because it was a French one; the brilliant but reckless career of Ismail, his enterprising views and extravagant speculations, ending in his fall; the attempts, under Tewfik, to remedy the distress which Ismail had brought on; the rebellion of Arabi and the raid of the Mahdi, with Gordon's unfortunate career. England's record, through all these events, has been rather spotted, but Mr. Bowen concludes that "England, in spite of all her mistakes, has had a beneficent influence on Egypt," and that the hope of the country hangs largely on its independence of Turkey being assured.

The Poison Problem. By Felix L. Oswald, M. D. New York: D. Appleton & Co. Pp. 138. Price, 75 cents.

In this little volume, Dr. Oswald, than whom no writer is braver, more pungent upon occasion, or more readable, discusses the cause and cure of intemperance. In the beginning he calls attention to the extent and enormity to which the consumption of liquors has grown, and the power the liquor-traffic has acquired, which are really facts to be alarmed about. The argument is based upon the assumption, which is maintained by many considerations, that alcohol is a poison without any beneficial qualities to the system, the appetite for which, when once acquired, grows, and can not be mitigated by any measures of mere temperance, or by compromises. No moral or social evil is greater than those to which it conduces. "Judging from secular standpoints," says Dr. Oswald, "we should be inclined to think that alcohol is doing more mischief in a single year than obscene literature has done in a century. . . . And, unhappily, it also involves the loss of self-respect, and thus destroys the basis on which the advocate of appeals to the moral instinct would found his plan of salvation. The power of moral resistance is weakened with every repetition of the poison-dose, and we might as well besiege a bedridden consumptive with appeals to resume his place at the head of an afflicted family." The banishment of alcohol from the sick-room, as well as from the banquet-hall, is demanded. "Thousands of topers owe their ruin to a prescription of 'tonic bitters.' . . . Taught by the logic of such experiences, the friends of reform will at last recognize the truth that the 'temperate' use of alcohol is but the first stage of a progressive and shame-proof disease, and that, moderation and repudiation failing, we must direct our blows at the root of the upas-tree, and adopt the motto of 'eradication.' Truce means defeat in the struggle against an evil that will reproduce its seed from the basis of any compromise." For remedies against the spread of the alcohol-habit, the author proposes instruction respecting the physiological effects of the drug, such as is provided for in the school systems of several States; proscription of its use under all circumstances; the provision and encouragement of healthier amusements, from which alcohol shall be conspicuously absent, as it is now conspicuously present in or near most ordinary amusements; and prohibitory legislation. Our temperance friends will hardly find a stronger document in support of their cause than Dr. Oswald offers them.

The Old Order changes. By W. H. Mallock. New York: G. P. Putnam's Sons. Pp. 513. Price, $1.

Mr. Mallock, the author of "Is Life worth Living?" is well known as a forcible writer on morals and social questions. The present book is a love-story, in which are interwoven discussions of the "labor problem" and "scientific morals." The bearing of the whole may, perhaps, be learned from the motto, which is a sentence of Bastian's, translatable into—"This importunate political economy insinuates itself everywhere, and mixes itself in everything, so that I really believe that it is it that says, 'I think nothing human foreign to me.'"

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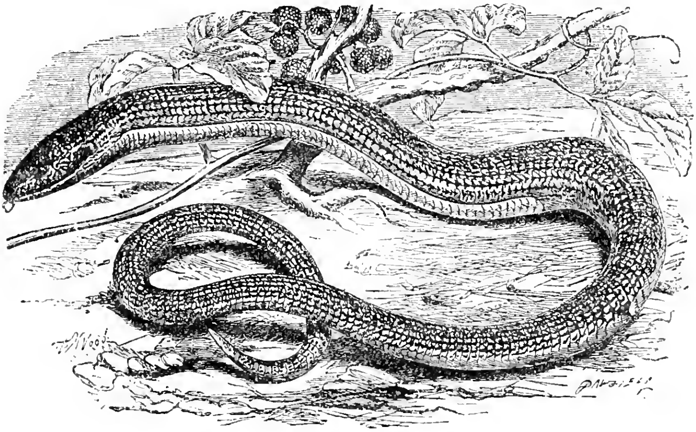
POPULAR MISCELLANY.

The Glass-Snake.—We publish in this number of the "Monthly" two letters respecting the so-called joint-snake, of which the one by Dr. Hammond gives a clear and correct account of the natural history of the reptile, and ought to dissipate all doubts as to the origin and value of the stories that have been told respecting its peculiarities. It appears that the rejoining of the dissevered pieces of the animal is the only part of the stories that does not rest upon a rational foundation. The *Ophisaurus* of Dr. Hammond is also figured and described in Wood's "Natural History," from which the accompanying illustration is borrowed (Vol. III, p. 51), under the name of "the glass-snake." After speaking of the reptile as a native of North America, Dr. Wood says: "In this creature there is not even a vestige of limbs, so that it is even more snake-like than the preceding species [Scheltopusic, *Pseudopus Pallasii* of Africa]. The generic title of Ophisaurus is of Greek origin, signifying snake-lizard, and is given to the reptile on account of its serpentine aspect. The reader will remember that on page 48 there is an account of the saurophis [*Saurophis tetradactylus* of South Africa, which has four insignificant, very weak limbs], a name which is exactly the same as that of the present species, except that the one is called the lizard-snake and the other the snake-lizard, a distinction which, in the present case is without a difference, so that the two reptiles might exchange titles and yet be appropriately named. The glass-snake is indeed so singularly like a serpent that it can only be distinguished from those reptiles by certain anatomical marks, such as the presence of eyelids, which are wanting in true serpents, the tongue not sheathed at the base, and the solid jaw-bones, which in the serpents are so loosely put together that the parts become widely separated when the mouth of the creature is dilated in the act of swallowing its prey. The glass-snake is one of the earliest of the reptile tribe to make its appearance in the spring. . . . It is generally found in spots where vegetation is abundant. . . . It is fond of frequenting the plantations of sweet-potato, and during harvest-time is often dug up together with that vegetable. The home of this reptile is made in some dry locality, and it generally chooses some spot where it can be sheltered



Glass-Snake (*Ophisaurus ventralis*).

by the roots of an old tree, or a crevice in a convenient bank. It moves with tolerable rapidity, and its pursuer must exercise considerable quickness before he can secure it.

"To catch a perfect specimen of the glass-snake is a very difficult business, for when alarmed it has a remarkable habit of contracting the muscles of its tail with such exceeding force that the member snaps off from the body at a slight touch, and sometimes will break into two or more pieces if struck slightly with a switch, thus earning for itself the appropriate title of glass-snake. Our common blind-worm . . . possesses a similar capacity, and often uses it in rather a perplexing fashion. Catesby remarks that this separation of the tail into fragments is caused by the construction of the joints, the muscles being articulated in a singular manner quite through the vertebræ. The tail is more than twice the length of the body, from which it can only be distinguished by a rather close inspection. The head of the glass-snake is small in proportion to the body, rather pyramidal in shape. Along each side of the body runs a rather deep double groove. The coloring of this creature is extremely variable."

Antiquity of Speaking Man.—In considering the question of the antiquity of speaking man, Mr. Horatio Hale avails himself of the theory which was suggested to Professor de Mortillet by the structure of a jaw-bone found in the cave of La Naulette in Belgium, that palæolithic man, who in this case could with more propriety be styled the precursor of man, was speechless. The jaw-bone in question is destitute of what is called the "mental tubercle," or the "genial tubercle," an appendage peculiar to man, which is indispensable to that freedom of the movements of the tongue that is essential to the possession of articulate language. Such a speechless man as this one may have been would be, as Professor Whitney remarks, "a being of undeveloped capacities, having within him the seeds of everything great and good, but seeds which only language can fertilize and bring to fruit; he is potentially the lord of Nature, the image of his Creator, but in present reality he is only a more cunning brute among brutes." Having reached a certain level, it is impossible for him to go above it. Hence, the dead uniformity in the character of the relics of man of this race. The next race, the race of Crô-Magnon, offered in some respects the strongest possible contrast to this one. It possessed the genial tubercle, with good cranial development and intellectual powers, the refinement of which is attested by the pictures it has left engraved on pieces of stone, ivory, and bone, and sculptures on bone and ivory, the spirit of which would be creditable to any artist. It is impossible to suppose that people possessing such faculties and speech would remain long in an uncivilized state if they were once placed in a country where the climate and other surroundings were favorable to the increase of population and to improvement in the arts of life. Various calculations of the age at which this race flourished place it at from four to eight thousand years ago, which is fairly consistent with the accepted chronology of the prehistoric life of the oldest historical nations, and we thus have the early origin and sudden outburst of civilization in ancient Egypt and Chaldea accounted for. If a pair of human beings, possessing the gifts supposed, appeared in some region where the climate and natural productions were favorable, what time would be required for their descendants to become numerous enough to found the early communities of Egypt and Mesopotamia, and to spread into Europe and Eastern Asia? "The question is easily answered. Suppose the population to double only once in fifty years, which is a very low estimate, it would amount in twelve hundred years to about forty million, and in fourteen hundred years would be over six hundred million, or nearly half the present population of the globe. That less than a thousand years will suffice to create a high civilization, the examples on our own continent, presented by the Mexicans, the Mayas, the Muyscas, and the Peruvians, amply prove. And that the same space of time would be sufficient for the development of the physical peculiarities which characterize the various races of men, by climatic and other influences, is made clear by the evidence accumulated by Prichard, De Quatrefages, Huxley, and other careful and trustworthy investigators."

The Canadian Climate.—In a paper on "The Influence of the Canadian Climate on Europeans," which he read at the British Association, Professor W. H. Hingston said that the heat of the summer in Canada was more easily endured than the humid summer weather often experienced in Europe. The skin was called into greater activity, and the heat of the summer weather acted very strongly on the liver; but if European residents adopted the indigenous customs of the country, lived moderately and temperately, and led an active existence, their livers would give them no trouble. The cold weather in winter stimulated people to activity. The mortality in early life was large, because in no country in the world were there so many children, but the mortality in adult life was not large. With the exception of Malta, the Canadian stations used to be considered the healthiest posts of the British army; and there were really no diseases peculiar to the country, while many which prevailed in England and on the Continent of Europe had no existence there.

The Carpet-Beetle.—The carpet-beetle, which is commonly, but with no good reason, called the buffalo-moth, is a dermestoid beetle whose scientific name is *Anthrenus scrophulariæ*. It is a foreigner, and was introduced into this country from Europe in 1872. It has since made itself at home in every part of the United States. It is about one twelfth of an inch long, and is prettily marked with regular patches of white and red upon a prevailing black ground. It feeds upon the pollen of flowers, of which it gives the preference to spiræa. It is destructive to carpets, and to nearly all animal substances, in the larval state. Carpet-linings give protection against the pest to all of the carpet they underlie, but the part of the carpet near the base-board is unprotected, and is liable to be infested and eaten by them. It is there that defensive measures should be applied. The beetles are nearly proof against ordinary moth-exterminators, and call for stronger remedies. Benzene is one of the best of them; it is efficient, simple, not dangerous, and easily applied. It can be poured on from a tin can having a slender spout, with a nozzle that will let out a stream as large as a knitting-needle. Naphtha, kerosene-oil, and gasolene are remedies of similar character and likewise easily used. Kerosene and naphtha are a little objectionable on account of their odor; kerosene also on account of its greasiness, and gasolene on account of its inflammability. Ironing wet cloths applied over the edges of the carpet is recommended; the beetles are killed by the steam that is generated. Painting with corrosive sublimate bed-bug poison is a sovereign remedy for all vermin. The beetle does its worst work in June, July, and August. The larvæ live in the cracks of the floor during the winter; and it is feared that, under the present methods of heating, the habit of producing a second brood in the colder months is likely to be induced.

The Ruins of Quirigua, Central America.—The ruins of Quirigua, in Central America, according to the account of Mr. A. P. Maudsley, are completely hidden in a thick tropical forest, on the left bank of the river Montagua. They consist of numerous square or oblong mounds and terraces, varying from six to forty feet in height, some standing by themselves, and others clustered in irregular groups. Most of these mounds were faced with marked stone, and were ascended by flights of stone steps. "The interest centers in the thirteen large carved monoliths which are arranged irregularly round what were probably the most important plazas of the pueblo. Six of these monuments are tall stones measuring from three to five feet square, and standing from fourteen to twenty feet out of the ground; five others are oblong or rounded blocks of stone shaped so as to represent huge turtles or armadillos, or some such animals. All these monuments are covered with elaborate carving; usually on both back and front of the tall monoliths is carved a huge human figure standing full-face, and in a stiff and conventional attitude. The sides of the monuments are covered with tables of hieroglyphics, most of them in fairly good preservation. In addition to these tables of hieroglyphics, there are series of squares or cartouches of what appears to be actual picture-writing, each division measuring about eighteen inches square, and containing usually two or three grotesque figures of men and animals. The design of these picture-writings shows considerable variety and freedom of treatment as compared with the large-sized human figures, in the execution of which the artist seems to have been bound by conventional rules. The largest of the stone animals is perhaps the most remarkable of all the monuments; its measurement is roughly a cube of eight feet, it must weigh nearly twenty tons, and it rests on three large slabs of stone. It is shaped like a turtle, and is covered with the most elaborate and curious ornament, and with tables of hieroglyphics and cartouches of picture-writing. The greater part of the ornament throughout these carvings is formed from the grotesque representations of the human face or the faces of animals, the features frequently so greatly exaggerated that it is most difficult to recognize them; but a careful examination enables one almost invariably to trace back to this facial origin what, at first sight, appears to be merely conventional scroll-work. Forms derived from leaves or flowers are altogether absent; occasional use is made of a plaited ribbon, and a very free use of plumes of feathers, which are often most gracefully arranged and beautifully carved. The fifteen monuments are divided into two groups; in one the human figures are all of men; in the other, of women. It might be rash to argue from this that women had attained a high place in the social arrangement of the people who raised these monuments; but there is one other feature that certainly may be admitted as showing an advanced and peaceful condition of existence, and that is the entire absence of any representation of weapons of war." Casts of the largest of the monoliths, of the turtle, and of all the tablets of hieroglyphics, are on exhibition in the Archæological Museum at Cambridge, England.

Petroleum in Egypt. — Oil has been "struck" in Egypt by boring in the Jebel Zeit (Oil Mountain), on the shore of the Red Sea, one hundred and eighty miles from Suez. Petroleum has long been supposed to exist in the country, for the ancient mummy-cloths were soaked in it, and the exudations from the fissures of this very mountain have been used by the natives, from time immemorial, as a specific for rheumatism and skin-diseases. Oil was definitely mentioned as a production of the Red Sea country, and an analysis of a sample of it was given in a book published by Mr. Norman Tate, in 1864, but nothing more precise is known concerning the statements he makes. Some two years ago, M. Debay, a Belgian engineer, proposed to exploit for petroleum, and finally obtained a concession to do so, which was to expire on the first day of March, 1886. He started his borings after a long delay, and at last, on the last day of the life of his privilege, got at the depth of thirty-five metres signs of oil sufficient to satisfy the conditions of his contract. With continued borings an outflow of five hundred tons of mixed water and petroleum has been obtained, of which the pure petroleum constituent was estimated at at least one hundred and fifty tons. The Egyptian Government is looking out for companies to work its oil. It intends to avoid a monopoly, and will divide the land into portions, which will be ceded for a sum in cash and a royalty on all production.

The Theory of Earthquakes.—Professor J. S. Newberry defines an earthquake, so far as present knowledge permits it to be defined, as a movement caused by a shrinking, from the loss of heat, of the heated interior of the earth, and the crushing together and displacement of the rigid exterior as it accommodates itself to the contracting nucleus. As the nucleus contracts, the solid crust can not accommodate itself, moment by moment, to the loss of volume, for it resists by its rigidity and is brought into a state of strain. This is relieved from time to time, whenever it passes the resistance of the materials composing the crust, by a crushing together and displacement of the surface rocks. These are faulted or folded; that is, are either thrown into great waves by lateral pressure, or the arches are broken and fissures are produced at right angles to the line of thrust. The rocks forming the sides of these fissures slide on each other, forming what geologists call faults, in which the "throw" or displacement sometimes amounts to many thousand feet. Earthquakes, mountain-chains, and volcanic eruptions may all be considered as consequences of this readjustment. It is evident that the folds and fractures seen in every mountain-belt could not have taken place without great disturbance of the surrounding country; and as they have been formed, not all at once, but each by itself, and each one by many paroxysms, an almost infinite series of earthquakes is recorded in the structure of every mountain-chain. The lines of fracture which are marked by mountain-chains are ever, after the first disruption, lines of weakness, where the resistance to lateral pressure is diminished, and where the strain of large unbroken areas is relieved from time to time by displacements, necessarily attended by earthquakes. So along up the Atlantic slope of the Alleghanies there have been many earthquakes since the country was occupied by the whites. Not a year passes that we do not hear of several in New England, the Middle, or Southern States. As the population increases, the number of observers is multiplied and the number of structures liable to damage constantly added to; so that such phenomena now attract more attention and cause greater destruction than formerly. When the data already collected in regard to the Charleston earthquake shall have been tabulated, it will doubtless be found that the displacements which occasioned the vibrations were located along a line parallel with the Alleghanies and at a depth of from ten to twenty thousand feet, not under but westward of the city.

The Ornithorhyncus.—Dr. Pfuhl, in his lecture on "Animal-Plants and Plant-Animals," published in our last number, spoke of the ornithorhyncus as being a true mammal, and bringing forth its young alive. Such was believed to be the case till very recently. Mr. W. H. Caldwell, who has resided for some two or three years in Australia engaged in special investigations of the mysteries connected with the mammals of that country, has recorded the discovery that the monotremata, or animals of the order of which the ornithorhyncus is a member, are oviparous, and lay eggs, the development of which bears a close resemblance to the development of the eggs of the reptilia. He has read several papers relative to his investigations before the scientific societies of New South Wales, in one of which, before the Linnæan Society, he exhibited specimens that he had obtained in Queensland, showing the stages in the development of the animals from the laying of the eggs to the hatching.

Some Inherited Phenomena of Alcoholism.—Dr. T. D. Crothers, of Walnut Lodge, Hartford, Connecticut, has made a study of a class of phenomena which have not been previously described specifically, in which a liability to exhibit the outward signs of intoxication upon excitement appears to have been inherited from inebriate parents. He has found two classes of the cases: one, in which the symptoms of intoxication are present all the time; the others in which those symptoms only appear from some peculiar circumstances or exciting causes. In the first class, some prominent defect, such as idiocy, imbecility, or congenital deformity, is present to give the case a distinctness irrespective of the signs of intoxication. The symptoms may appear after birth, or be slowly evolved with the growth of the child, and come into prominence at or before puberty. Of course, all the varied phases of idiocy, imbecility, progressive degeneration, and malformation go on. The presence of a special class of symptoms resembling intoxication so clearly, suggests a distinct alcoholic causation. In the second class of cases noted, the alcoholic symptoms are not present, unless from some exciting cause (non-alcoholic), such as anger, fear, or sudden excitement. In this class are idiots, imbeciles, and defectives of all degrees, who at times display distinct signs of intoxication, that subside after a period. Often in these cases appear the common delusions and deliriums of intoxication; also, the semi-paralysis and stupor. Teachers and superintendents of asylums and schools for this class realize clearly the danger of excitement on these dements and defectives, throwing them into various states of mania, as well as intoxication. Several remarkable incidents illustrative of these principles are cited, the grouping of which makes it evident to the author that symptoms of alcoholic poisoning can not be trusted as evidence of the immediate use of alcohol; and that the excessive use of alcohol leaves a permanent defect or impress on the brain, which will go down into the future with great certainty. It may be concealed for a lifetime in the child of a drinking parent, but may come to the surface at any moment, from the application of its special exciting cause; or it may appear in some other form of defect, which can be traced back to the injury from the toxic action of alcohol.

Potable Water. — The unsatisfactory character of all purely chemical examinations to determine the wholesome potability of water has long been tacitly admitted. It has more recently been demonstrated that such examinations do not go to the root of the matter, for the quality of water is dependent on the presence or absence of certain bacterial growths. Frankland's combustion process, Wanklyn's ammonia process, and Schützenberger's permanganate of potash method, were all attempts to estimate the organic matter, and, to some extent, its qualities; but they, and all chemical processes, deal with dead matter only, or, rather, fail to draw any distinction between the living and the dead; and, judged by these standards, the water in which vegetables have been boiled, or a cup of meat-broth, or of coffee, would rank far worse than water containing a small quantity of enteric or choleraic stools, or even than the anthrax-bearing waste from a mohair-factory. Bacterioscopic examination of water, the object of which is to determine the bacterial life, or the disease-germs and their activity, has been employed for some years in Germany, and is making headway in England. By this method we are enabled to ascertain the number of living bacteria in a cubic centimetre of water. Koch's results showed the relation between this number and the purity of waters, as well as the effect of filtration, when he was able to announce that the numbers were, for Berlin sewage, 38,000,000; for the waters of the Spree, 118,000; for the effluent from sewage-farms, 18,000; from the Rummelsberger See, 32,000; from the Stralau water-works, before filtration, 125,000, and after filtration, 120. In the best well-waters it is from 30 to 60, and in boiled distilled water from 4 to 6. From this it appears that any number under 100 indicates an irreproachable water, and under 200 a potable one; while polluted rivers count their thousands and sewage its millions. Still, this method fails to distinguish between innocent and pathogenic organisms. Some of them can be identified by their mode of growth in tubes of nutrient gelatin, by their behavior with coloring reagents, and by other methods, even when in themselves morphologically alike and indistinguishable under the microscope. Dr. Dupré suggests an easier and speedier plan, dependent on the fact that some microbes can and others can not survive exposure to certain degrees of heat, and that while dead matter rapidly absorbs oxygen from permanganate of potash, it does so to a very slight extent, if at all, from the water itself, at least within a limited space of time. He is directing his attention to the points that the amount of oxygen taken from the water in its natural condition may be contrasted with that taken from the permanganate; that it may be contrasted with that taken up after any living organisms in the water have been killed by the application of heat; that a degree of heat may be applied sufficient to kill developed organisms or certain germs and spores, but insufficient to kill other kinds of germs and spores, and if this degree of heat be known for the several kinds of germs and spores, a judgment may be formed as to the nature of the germs and spores present; and that some substances, sterile in themselves, but capable of nourishing any living organisms contained in the water, may be added, and the increase in the amount of oxygen absorbed may be noted. Among the practical results to which Dr. Dupré has come, are: A water which does not diminish in its degree of aëration, or, in other words, which does not consume any oxygen from the dissolved air, may or may not contain organic matter, but presumably does not contain growing organisms. Such organic matter, therefore, as on analysis it may be found to contain, need not be considered as "dangerous organic impurity"; a water which, by itself, or after the addition of gelatin or other appropriate cultivating matter, consumes oxygen from the dissolved air at lower temperatures, but does not consume any after heating to 60° C. for three hours, may be regarded as having contained living organisms, but not of a kind able to survive exposures to that temperature; and a water which, by itself or after the addition of gelatin or the like, continues to consume oxygen from its contained air after the water has been heated to 60° C., is to be regarded as containing spores or germs of organisms that can survive that temperature. Whether the power of resisting a given temperature affords any clew to the innocence or malignity of an organism is a question for future biologists, and must be decided by separate observations on each known species.

Amianthus.—Amianthus is a mineral consisting of a double silicate of hydrate of lime and magnesia with a little oxide of iron or alumina. It generally occurs in the form of silky fibers, sometimes nacreous and having a greasy feeling, qualities that give it a kind of organic aspect. It is incombustible and infusible. It appears to burn in the fire, but when it is withdrawn from the flames it immediately returns to its natural condition without having undergone any alteration. This property seems to have been known from very early times. The ancients are said to have used it for winding-sheets for the bodies they placed upon the funeral-pyres, the cloths made of it holding the ashes of the dead separate from those of the fuel. Whether this be so or not, the secret was lost, and amianthus was, till quite recently, nothing but a natural curiosity. The art is now practiced of introducing amianthus into woven goods and of making with it a considerable number of incombustible objects, such as gloves, garments, and safety-ropes. It has also been introduced into paints and protective coverings for wood. As it is a poor conductor of heat, is not attacked by acids, and does not act on metals, it makes a good envelope, and has been found excellently adapted to application at the joints of steam-pipes. The manufacture of amianthus is carried on by an English company formed by the amalgamation of three rival Anglo-Italian companies, which has control of the most important beds of asbestus known, particularly of those in England, Italy, Corsica, and Canada. The Italian asbestus is most sought after, on account of the length, fineness, softness, and flexibility of its fibers. The fibers of the mineral of other countries are shorter, harsher, and less easily separated, and, therefore, inferior. The fibers, the mineral having been passed through a rolling-mill, are stirred in a bath of hot water till they become very supple. The longer fibers are then taken out, washed, and sorted into packages of uniform length, to be spun into threads and woven into cloths, for garments of various kinds, or into cords. The shorter fibers are beaten into a powder, and then mixed with linseed-oil into a pulp very like paper-pulp, to which India-rubber is added to give elasticity; and this makes an excellent paint for protection against heat, particularly suitable for application to steam-conductors, boilers, joints, furnishing of every kind, and wood.

A River made a Nuisance.—The "Lancet" records the failure of the system which has been applied, with great expense, for disposing of the sewage of London by turning it into the lower part of the Thames. It declares it the greatest nuisance of England, and charges it with having made the Thames a cesspool throughout its tidal region. "Of the existence of a tremendous nuisance," it says, "and of the urgent danger to which it exposes the metropolis, there is no longer any room for doubt. Hard as the Metropolitan Board of Works fought, they were utterly crushed by the evidence brought before the late Royal Commission, and by the stinging words of the commissioners in their reports. They have, indeed, practically admitted the whole case against them by adopting a costly system of disinfection which could only be justified by urgent necessity. The disinfection, it is true, is a sham, utterly useless, and a gigantic waste of the money of the rate-payers; but it is none the less a confession of the existence of a nuisance created by the board, and for many years defended by them as a public blessing."

The Blue Grotto of Busi.—The "Blue Grotto" of the Island of Busi, in the Dalmatian Archipelago, which is illuminated by submarine light, was discovered in 1884, and has become one of the most noteworthy sights of that interesting quarter of the Adriatic. The Island of Busi, which is inhabited and well cultivated, takes its name from the Venetian *busi* (Italian *buchi*) caves, on account of the dozen, more or less, of grottoes that exist upon it. It lies southwest of the Island of Lissa, and being only about five miles from the port of Cornise on that island, can be reached from it after about seventy or eighty minutes of rowing. It is rich in subterranean and submarine caverns, which have been only partly explored. Count von Ransounet is acquainted with ten of these, all accessible only by boat. The largest of them, which is called Medvedina, or the Bear's Cave, is about five hundred feet long, and presents a spacious interior with imposing rock-effects. The most remarkable of the caves so far explored, is the Blue Grotto, which is called by the inhabitants the ballon-cave, from the name of the rock promontory Ballon, on the northeastern coast of the island under which it lies. The entrance to the cave is in the farthest recess of a bay on the northeast side of the island, and is about seven feet wide and five feet high, with sixteen feet depth of water, and spacious enough to admit, when the sea is still, a boat carrying ten or twelve persons. This entrance forms a thread-like canal, inclosed between steep walls, which is shrouded in its first half in deep darkness; but the farther one presses in, the more evident and clear becomes a peculiar twilight effect, by which one can soon discern the breadth and height of the interior, illuminated by a surprising play of colors. At first the water under the keel of the boat appears of a dark blue-green; then the color gradually changes to a clear blue, and at last to an azure, which grows lighter and brighter. Soon the visitor finds himself set, as if by enchantment, into a broad, high space, the ground of which is filled with a brilliant, shimmering, blue flood, whence streams out a soft light, covering everything visible with a strange glamour. The illumination appears to come from under the sea. The oars appear silver-white in the transparent blue flood, and the stones under the water like semi-lustrous silver, while the waves themselves exhibit the various changes of the shades of blue. The hollow of the grotto is thirty-one metres long, from fifteen to seventeen metres wide, and between sixteen and eighteen metres deep. The water, which appears to extend still farther under the rocks, receives its light through a submarine door of ten and a half by eighteen metres; and the silvery shimmer with which the submerged rocks are lighted is an effect of the sunlight reflected from the water. This effect is particularly charming on a rock-bridge under the water, extending clear across the cave. Beyond this bridge may be seen, through a cleft in the rock, a second blue cave of smaller dimensions and different light-effects.

British Health Resorts.—The health resorts of Great Britain have the advantages—to Englishmen—of being convenient of access and of being conducted according to British ideas of comfort. Their disadvantages are those of a cool and humid climate, and the long, dreary, sunless winter. The sea-side resorts are probably the most important. Of them, those of the east coasts—Ramsgate, Cromer, Redcar, and Whitby—are stimulating; those of the west, especially of the southwest—Bournemouth, Torquay, Penzance, and Ilfracombe—sedative; and those upon the southeastern littoral—Eastbourne, Folkestone, and Hastings—hold an intermediate position. The selection must depend upon the physician's appreciation of the finer points in his patient's case, but it is far from being a matter of indifference, and the indiscriminate recommendation of sea-air, without regard to the different watering-places, is an inexcusable error. If the invalid is intolerant of marine influence, he may make a selection from a variety of inland resorts. Tunbridge Wells is mild and sheltered, Malvern is more tonic, and Buxton, Ilkley, Harrogate, Weymouth, and Crieff are bracing and stimulant. The gouty and rheumatic may find benefit at the mineral springs of Bath, Cheltenham, Droitwich, Matlock, Leamington, Woodhall, and Harrogate in England, Moffat and

Strathpeffer in Scotland, and Ballynahinch and Lisdoonvarna in Ireland. But these places are now not so much in fashion or so attractive as the Continental resorts, and afford, as Dr. Yeo has pointed out, an inferior variety of advantages. The great variableness of English seasons is, however, very embarrassing in the case of consumptive patients, although there are places among the milder resorts where benefit is derived in favorable seasons. Great Britain is, however, wholly without places where the rarefied air of great altitudes can be applied to cures, as at Davos Platz, and will probably never have them, for the British winter presents meteorological conditions diametrically opposed to the brilliant sunshine and intense dryness to which the climate of the upper Alps owes a large part of its efficacy.

The Inconveniences of Law-Codes.—Mr. E. T. Merrick, in a letter to David Dudley Field and others, committee on the delay and uncertainty of judicial administration, objects to the formation of codes, as tending to give laws too rigid a character. According to his reading and observation, "the transition from the elastic system of principles, resting on pure reason, to a system of positive law, is marked at first by a liberal interpretation corresponding more to the equity of the older system. But, little by little, from veneration or some other motive or cause, the words of the statute law are considered of more sanctity and come to be more rigorously executed, until at last it is thought that it is of more importance that the law should be strictly observed than that equity should be done. How often have the judges felt constrained to enforce statutory laws, against which their sense of justice revolted!" It would be much better, in Mr. Merrick's view, to leave it to wise judges "to select from the great storehouse of principles, which admit of an infinitude of exceptions, such as are fitting the new subjects brought for their determination, than to leave it to less experienced men who happen to have the power as legislators to freeze principles into rigidity." Codes may be a matter of necessity under some circumstances, but room should be left in every system of laws for adaptation of judicial construction to special conditions and contingencies, "for it seems presumptuous in any body of men to attempt to regulate, by absolute terms, future affairs and rights respecting things the existence and relations of which they can not possibly foresee." Provision for giving flexibility to the English common law is afforded by chancery; and in the United States, the opinions of the courts of every State are exerting more or less of influence on the courts of every other State, on all questions arising under the common law, whereby the judges of all the States are building up one homogeneous system.

Meerschaum.—Meerschaum ranks among the most important mineral products of the Turkish Empire. It is a magnesite or hydro-silicate of magnesia, and is found in extensive masses in the lower transition beds, in the Crimea and the Island of Negropont, but most abundantly in Asia Minor. The center of the principal district where it is mined is at Eski-Sheir, the ancient Dorylaion, a town of nine thousand inhabitants, situated in a valley watered by the Thymbres River, in a district famous for its thermal waters. Most of the meerschaum mined here is exported by way of Brusa to Vienna, while the waste is bought by the North-German manufacturers of pipe-bowls and mouth-pieces, whose chief center is at Rubla, in the Grand-duchy of Saxe-Weimar. Some twenty beds of the magnesite are worked near Eski-Sheir. They belong to the Turkish Government, but are farmed out to European companies, some of which have been on the ground for more than twenty years. The companies employ some four thousand workmen, who come chiefly from Germany and Italy. Magnesite earths are also found at Vallecas, near Madrid, in Spain, under saliferous clays, at Salinelle, in the department of the Garo, and at Saint-Ouen and Coulommiers, France, where they occur in fresh-water beds under the gypsum.

A Fruit-Evaporator for the Public.—The Fruit and Vegetable Growers' Association of the United States, at its meeting in Columbus, Ohio, gave especial consideration to the question of the best methods of preparing fruit for the market and preserving it for family use. The method by evaporation was especially commended. Mr. Ezra Arnold, of Illinois, presented drawings and specifications of a cheap evaporator made and used by himself, with which he had had better success than with the more expensive dry-houses and evaporators. It is very simple in construction, and with it the inventor could dry apples in two hours; strawberries in three hours; peaches, cherries, and corn in two hours, etc. He did not intend to make or sell evaporators, but would consign to the Association his right and title in the invention, provided that body would procure cuts to illustrate the different parts, and would distribute gratuitously complete illustrated directions for making and using the evaporator. His proposition was accepted by the Association. (W. Orlando Smith, secretary, Alliance, Ohio.)

The Mexican Luminous Beetle.—Carl Heinemann, of Vera Cruz, has published observations of the Mexican *cucuyo* (*Pyrophorus*), or luminous beetle. Each beetle has three lamps—a pair of small lamps on the prothorax, near the margin, and a large lamp in its abdomen, all developments of the hypodermis, and largest in the male. Though the light is usually nocturnal, yet, if the animal is disturbed by day, it will shine, but less brilliantly, and a sleeping *cucuyo* will show in a dark chamber a mild light; and if at such time it is awakened, and breathing begins, the light will appear in its splendor. There are two degrees of luminosity—one soft and the other bright—which may be termed, respectively, the cell-light and the tracheal light, and one may change into the other by stimulation. In a dark room the light appears clear green, inclining to blue; in daylight it is yellowish. The spectrum analysis has not been satisfactorily effected, but the light seems to produce a spectrum wanting in half the blue and deficient in the red. An extracted luminous organ will continue to give red light for some hours. No light-nerves were found, and so far there was no evidence of the luminosity being under control of the will. The abdominal light, at least, depends only on the respiratory center. The expiration only of the abdomen is active, and the inspiration is the passive act of the abdominal muscles returning to their place of rest. On every such inspiration the air brought by the tracheæ causes the luminous organ to give its bright, steady light. It is manifest that the light depends on a process of chemical oxidation. Mechanical irritation, chemicals, and electrical stimulus never succeeded in exciting more than the mild cell-light. But a stream of atmospheric air, or of oxygen, brought out the brilliant tracheal light. For the continuance of the light, both oxygen and moisture are favorable. The luminous process goes along with the production of a greenish-yellow substance which is found diffused in the luminous cells; and this yellow can be fixed. The author believes that a substance is produced in the luminous organ which, on contact with oxygen, burns and gives out light. The ashes produced are rich in phosphoric acid, and from this he concludes that there is a burning of some phosphorous body.

Isochromatic Photography.—Mr. Frederic E. Ives, by washing his plates with a chlorophyl solution in addition to the ordinary preparation, takes photographic pictures in which all the colors and tones of color—including those which the ordinary plates do not return—are represented in their proper gradations of light and shade. A chlorophyl solution made from blue-myrtle leaves has been found to be the best, although that from a few other leaves may be equal to it. The quality of the plates, when they are to be used immediately, is improved if the solution contains a trace of eosine. But the chlorophyl solution without the eosine may, by adding a little zinc in the preparation, be kept for a considerable time without losing its efficacy.

NOTES.

The "Lancet" sees in precocity simply the early or premature use of the higher cerebral centers, particularly those which stand in near relation to the senses. Even when the higher intellectual centers are affected, the excitation may usually be traced through channels which originate in the senses. The calculating boy is gifted with a specially acute perception of sight- or sound-phantoms, which are so clearly apparent to his consciousness that he works out sums mentally with the ease of an expert using slate and pencil. In like manner a person of keen sound-phantoms may compose music or make verses.

Caoutchouc has been extracted from the *Sonchus oleraceus*, a common weed of the road-sides and barren places in France.

Madame Zaluska, in the "Revue Scientifique," is authority for the statement that the lowest temperature that M. Wroblewski has produced, by allowing liquefied hydrogen to escape, is — 211° C., or about — 380° Fahr. At this temperature, she adds, neither gases nor liquids exist, but everything is solidified. The metals lose their electric resistance, and the current passes through matter without developing heat in it.

The tides of the Mediterranean Sea, though much reduced, are as real as those of the ocean. Along the littoral of the maritime Alps they average from fifteen to twenty centimetres, with ten and twenty-five centimetres as the extremes. At Gibraltar, they rise to from 1·60 to 2 metres; at Trieste, to 0·70 metre; at Venice, from 0·50 to 0·60 metre; and in the Gulf of Gabes from a metre and a half to two metres.

Mr. J. Theodore Bent says that "binding is the spirit of the modern Greek charm. They bind diseases to trees; they bind fleas, bugs, and lice outside their houses, or rather they make ineffectual attempts to do so; and the shepherds of Donkey's Island (Gatharonisi) are careful to bind beneath the knee of a ram or he-goat the bone of a fish or hare, which they believe is effectual in preventing the offspring from being carried off by robbers."

The "Saturday Review," in noticing Professor Milne's book on "Earthquakes," accredits the author with having "probably done more than any man living to improve methods and apparatus for observation, and to find a scientific explanation of these crust-movements."

A company has been formed to apply the water-power of the falls of the Rhine at Schaffhausen to the electrical production of aluminium by the Cowles process.

The "Saturday Review" finds, in the character of the articles published in the "Sanitarian," evidence that Americans are not a whit behind the English in their appreciation of the inestimable value to a nation of due attention to the measures necessary for the preservation of health; but it also learns from one of the articles that both our national and State Legislatures "give but scant encouragement to those bodies which take care of the public health."

Professor Collett, of Norway, says that the beaver is now extinct in Northern Norway, but that about a hundred individuals are still living in some of the southern provinces.

A correspondent of the London "Spectator" objects to the wires now used instead of the old thread for stitching books, that in any but an extremely dry climate they are liable to rust and eat through the paper which they are supposed to fasten.

OBITUARY NOTES.

General William B. Hazen, Chief Signal-Officer of the War Department, died in Washington, January 16th, in the fifty-seventh year of his age. His death was unexpected, although he had been in bad health for a long time. He was born in West Hartford, Vermont, in 1830, and entered the Academy at West Point in 1851. After graduation, in 1855, he served for five years in the Indian campaigns of the West. At the beginning of the civil war he was assistant instructor of infantry tactics at West Point. Entering active service as a captain in the regular army, he recruited the Forty-first Regiment of Ohio Volunteers and commanded it. He served through the war in the West under Buell, Rosecrans, Thomas, Grant, and Sherman; participated in the principal battles of their campaigns, and was officially recognized, by promotion or brevet, several times, for conspicuous services. He was appointed Chief Signal-Officer in 1880, and distinguished himself in that capacity by his effort to enlarge and extend the weather-service.

M. Edouard Ernest Blavier, a distinguished French electrician, died on the 14th of January, in the sixty-second year of his age. He was inspector-general of the telegraphic lines, Director of the Superior School of Telegraphy, and Vice-President of the International Society of Electricians. He was the author of contributions to the learned societies, the "Telegraphic Annals," a "Course in Telegraphy," which is an authority on the subject, and a "Treatise on Electrical Magnitudes and their Measure in Absolute Unities."

Mr. John Arthur Phillips, who died suddenly on the 4th of January, was a chemist of considerable distinction for his researches in connection with mineralogy and metallurgy.

Mr. Thomas Moore, who was a prolific writer on botanical and horticultuaral subjects, and was for many years Curator of the Botanic Garden of the Society of Apothecaries at Chelsea, England, died on the 1st of January, in the sixty-seventh year of his age. He was best known for his numerous publications on ferns.

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