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EARTHQUAKE-PHENOMENA.

By ELIAS LEWIS, Esq.

IN the afternoon of the 1st day of June, 1638, 18 years after the landing of the pilgrims, there occurred the first earthquake in New England, of which we have an authentic record.

It is 234 years since that event, and, according to a catalogue prepared by W. T. Brigham, published in the Memoirs of the Boston Society of Natural History, it appears that, down to October 20, 1870, 231 earthquakes are recorded as having taken place in New England. From this able paper we learn that, in 1663, portions of Canada, New England, and New York, were convulsed by earthquake-shocks.

In 1727, at Newbury, and near the mouth of the Merrimac River, an earthquake took place during the evening when the atmosphere was perfectly calm and clear. The sound preceded the shock. The earth opened, and a sulphurous blast threw up mounds of calcined dust. Several days previous to the earthquake, water in the wells became fetid, and of a pale brimstone color. In 1755, on the 18th day of November, a hollow, roaring noise was heard in various parts of New England. In a minute the earth seemed to undulate as if a wave were passing. This was followed by a vibratory and jerking motion, familiar in earthquake countries. The first shock of this earthquake occurred 17 days after the terrible one at Lisbon, the vibrations of which had not yet ceased.

The great earthquake at New Madrid, in Missouri, took place in 1811–'12. The shocks here were vertical, proving, as we shall see hereafter, that the centre of energy was directly underneath. At other times, the shocks, which continued many months, were undulatory. The ground rose in huge waves, which burst, and volumes of water, sand, and pit-coal, were thrown high as the tops of the trees. The for-

ests waved like standing corn in a gale of wind, and an area 70 miles long by 30 miles wide was submerged, and became a swampy lake.

On the 13th of August, 1868, a fearful earthquake took place in Peru, which laid waste much of the country lying between the Andes and the Pacific. The shocks were felt through a distance of 1,400 miles north and south, and three important cities were destroyed. At Arequipa, in Peru, 40 miles from the sea, a slight undulatory shock was felt, followed by others so violent that in five minutes not a house was standing in that city of 44,000 inhabitants. A subterranean rumbling, like the rush of an avalanche, was heard above the crash, and a cloud of dust rose in the still air over the city. On the sea-coast were situated Iquique and Arica—both were destroyed by the shocks, and overwhelmed by a tremendous wave. The ocean thus took up the vibrations of the land, and waves of tremendous volume were put in motion, which rolled, not only upon the coast, but away from it with a velocity in the deep ocean of not less than 400 miles an hour. The great wave—for one was of much greater volume than the others—has been estimated at upward of 200 miles breadth, with a length along its curved crest of 8,000 miles. This rolled into the harbor of Yokohama, in Japan, 10,500 miles distant, and was felt at Port Fairy, in South Victoria, distant nearly one-half of the earth's circumference.

In 1797, a province of Ecuador, about 100 miles south of Quito, was visited by what is described by Humboldt as "one of the most fearful phenomena recorded in the physical history of our planet." The shocks were vertical, and occurred as "mine-like explosions." The town of Riobamba was over the central area, and many of its inhabitants were thrown 100 feet into the air.

The shocks, in this instance, were not announced by any subterranean thunder, but, just 18 minues after, a terrific roar was heard beneath Quito. It thus appears that shocks are not always preceded by sounds, nor do the sounds increase with the violence of the shock.

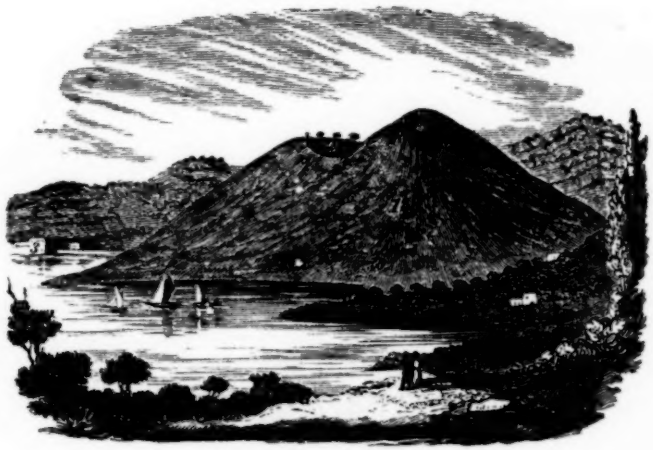
Sometimes, says Humboldt, there is a "ringing noise, as if vitrified masses were struck; again, a continuous rumbling and hollow roar; at others, a rattling and clanking as of chains or near thunder." With the lightning's flash we know that the danger is over, and await the coming thunder without alarm; but thunder, rolling deep in the earth, announces possible if not certain calamity.

Throughout the region of the Andes a connection between volcanic and earthquake action has been recognized by the people. It was supposed by Strabo that volcanoes are safety-valves, and scientific observation suggests that they may relieve the pressure and tension which would otherwise lay the earth in ruins.

For two years previous to 1538 earthquakes had been violent and frequent at Pozzuoli on the Bay of Baiæ, and elsewhere in the vicinity of Naples. On the 27th and 28th of September they did not cease day

or night. On the night of the 29th, flames issued from the ground near the baths of Nero, the earth rose and burst at the top with tremendous roar, and discharged steam, gas, pumice, mud, and ashes. A mountain 1,000 feet high was formed, known as Monte Nuovo, which, at the present time, is 8,000 feet in circumference, and 440 feet above

FIG. 1.



MONTE NUOVO.

the bay. The present aspect of Monte Nuovo is represented in Fig. 1, and the region around is shown in the frontispiece, from the last edition of Lyell's "Principles of Geology."

The Phlegræan Fields, of which Monte Nuovo now forms a part, have, in the opinion of Sir Charles Lyell, a "mutual relation with Vesuvius—a violent disturbance in one district serving as a safety-valve to the other—both never being in full activity at once."

In the Sandwich Islands, in 1868, Mauna Loa and the craters of Kilhauea on its flank were in active eruption. The valleys of the mountains were filled with rivers of fire, and a cloud of smoke and vapor arose, it is said, over the mountain, to a height of eight miles. During these fearful phenomena, which continued more than a month, 1,500 earthquake-shocks occurred, 300 of which were counted in five days. But whether shocks occur in the immediate vicinity of volcanoes during eruptions, or whether activity of the one diminishes the violence of the other, it is certain that they have a mutual relation, and probably a common origin.

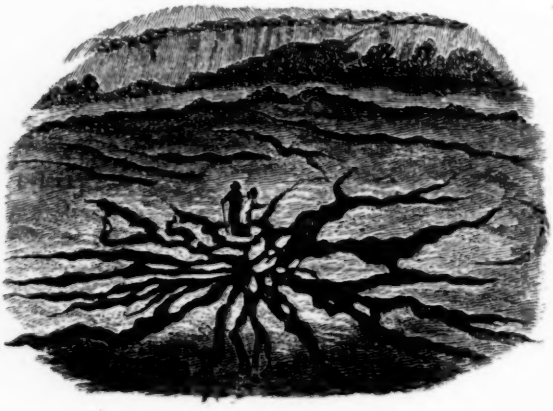
The opening and closing of fissures and chasms in the ground during earthquakes is a common phenomenon. Men, animals, and dwellings, are sometimes swallowed in them, and forever disappear. In 1848 an earthquake shook a large portion of New Zealand, and a fissure of great depth opened along a chain of mountains from 1,000

to 4,000 feet high, extending 60 miles, but of not more than 18 inches in average width.

During the Calabrian earthquake of 1783 the surface of the ground opened and closed in immense fissures, by means of which new lakes were formed and others drained or were dried up.

At Jerocarne the earth is described, by Sir Charles Lyell, as lacerated in an extraordinary manner. "Fissures ran in every direction, like cracks in a broken pane of glass."

FIG. 2.



FISSURES NEAR JEROCARNE, IN CALABRIA.

In another instance, several dwellings were engulfed in a fissure, and were found to be jammed with their contents into a compact mass. Chasms of immense length and depth were formed. Some were crescent-shaped, and a mile in length.

The plains of Calabria were covered in many places with circular hollows from one foot to three or four feet in diameter. Some of these were filled with water, others with dry sand.

Fig. 4 is a section of one of these circular holes, which appears to be funnel-shaped.

But changes in the earth's crust occur during earthquakes, on a still grander scale. Evidences of local disturbance, however disastrous it may have been, are often effaced if not forgotten in a few centuries frequently in a few years. But the slow upheaval of mountain-chains and the dislocation of strata through profound depths are results which alter at last the physical aspect and contour of the surface of the globe. It would not be proper, however, to say that these changes are caused by earthquakes, but rather that the earthquake vibration is a concomitant of the displacement by which they are produced.

Humboldt, Lyell, Dana, and other authorities, consider earth

quakes to be the dynamic result of action of the earth's heated interior upon its cooled exterior. Whether the central portions of the earth be fluid or not, it is quite certain that heat increases as we descend; and it is estimated by Sir Charles Lyell that the heat at a depth of 25 miles would be sufficient to melt granite, and at 34 miles to render fluid or incandescent every known substance. We have no means of knowing the condition of matter under the enormous pressure which prevails at a depth of 34 miles, and are most concerned with the fact that the heat of fusion exists at no very great depth beneath the surface. The earth's crust is, therefore, its cooled exterior.

Fig. 8.

Circular Hollows in the Plain of Rosarno.

It is found that nearly all rocks contract by cooling and expand by heat. Lyell estimates that sandstone a mile in thickness, and heated to 200° Fahr., would expand so as to lift a mass of rock upon it 10 feet above its former level; and if a mass of the earth's crust equally expansible, 50 miles in thickness, be heated to 800°, it would rise 1,500 feet. From cooling we have the reverse effect—shrinkage, contraction, lateral pressure, and ultimately bending of the strata.

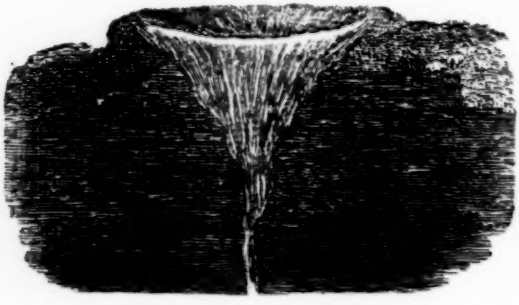
The strain thus produced will at last cause fracture, and the vibration that results is an earthquake. In Fig. 5 we have an illustration of fracture and displacement.

This form of tension is being continually and everywhere produced in the earth's crust, and there is probably no instant of time when that crust is entirely free from vibrations.

"There is nothing," observes Darwin, "not even the wind that blows, so unstable as the level of the crust of the globe."

Prof. Tyndall observes that, "where the acting force is small and the time great, the result is a slow and almost inappreciable change." Thus, great areas of land may be elevated or depressed. "But where the intensity is great and the time small, sudden convulsion must ensue." Thus, in an instant, mountains may undergo a change of elevation, or be shaken to fragments, or tracks of land sunken and overflowed. In the delta of the Indus are extensive areas of level ground, over which native villages were scattered, with fortifications and other defences. Of these, the fort at Sindree is shown in Fig. 7 as it was

FIG. 4.



SECTION OF ONE OF THE CIRCULAR HOLLOWS.

before the disastrous earthquake of 1819. 2,000 square miles of the delta sank from six to 12 feet, and was thus overflowed by the sea. The village of Sindree and its fortifications were upon the sunken area.

Northward, about 5½ miles from Sindree, a range of very low hills was elevated during the earthquake. It was seen over the expanse of waters, and extended about 50 miles, with a breadth in places of 16 miles, and was called by the natives, "Ulla Bund, or the Mound of God."

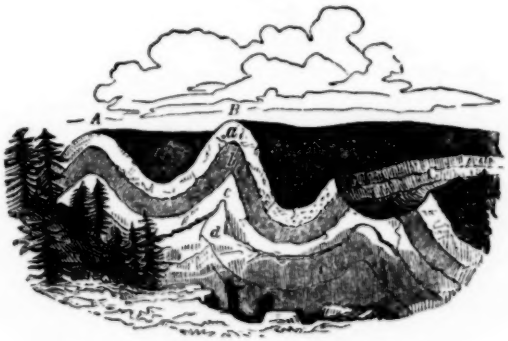
In 1822, just half a century ago, an earthquake occurred in Chili, of terrific violence, even for that region of convulsions. It was estimated that 100,000 square miles of land were elevated from two to seven feet, the rise being greatest inland, and probably included a portion of the Chilian Andes. The location of the force must have been at great depth, perhaps not less than 20 miles below the base of the Andes; and it is probable that the entire superincumbent mass underwent a change of level of from two to seven feet of perpendicular elevation.

The earthquake at Lisbon, in 1755, has impressed the public mind more than any other in modern times. The shocks, one of which exceeded all the others in violence, continued six minutes. The mountains near were shaken to their foundations, and everywhere split and rent. No part of the city was seriously injured which was built on the limestone or basaltic formations; but the shocks were most violent and

disastrous in the tertiary and blue clay on which the ruined portion of the city stood.

The sea-wave put in motion by this earthquake exceeded in volume all others of which we have a record, except the one already noticed, which traversed the Pacific Ocean in 1868. It was observed, during this convulsion, that the sea retired from the shore before the great wave rolled in.

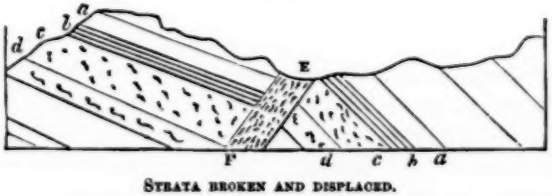
FIG. 5.



CURVED STRATA, AS SEEN IN THE SWISS JURA.

It was Darwin who first suggested that waves first draw the waters from the shore on which they are advancing to break. He calls attention to the familiar fact that waves thrown up by the paddles of a steamer, as they approach the shore, are alway preceded by a receding of the water. An under-draught seems to first suck the water back, and such actually is the fact. Now, in the sea-wave raised by the earthquake, what takes place? We have remarked that an

FIG. 6.



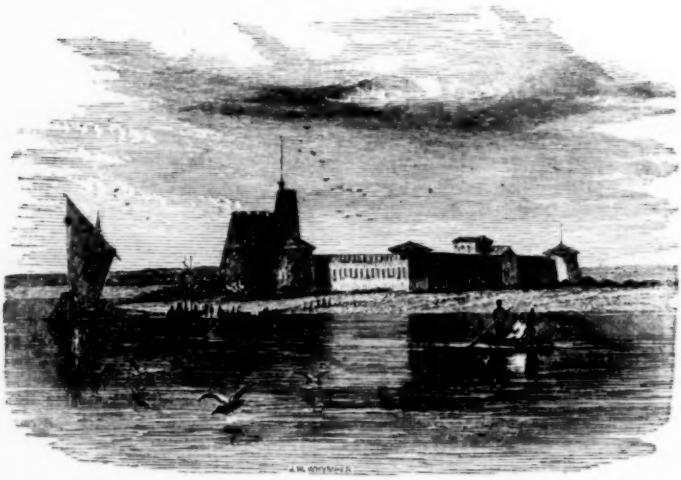
STRATA BROKEN AND DISPLACED.

earthquake is a vibration of the earth's elastic crust, and moves with tremendous velocity. When it occurs beneath the sea, or when the undulations reach the surface beneath the sea, the motion is communicated to the water, which it elevates in a wave. Simultaneously with this lifting of the water, an under-draught toward that point takes place. Were it not so, the elevation of the wave could not be sustained. Directly the great wave moves from the area of disturbance

at the rate before stated, of 400 miles an hour, or about 6⅔ miles in a minute, in the deep ocean. It is described by Mallet as "a low, broad swell of the sea. It might pass beneath the vessel unobserved." Approaching the shore, the front becomes elevated. The under-draught has continually preceded it, and has withdrawn the water from the shore, so that vessels at anchor are frequently grounded, and the wave seems to stand upon the bottom like a gigantic wall. At Arica it was unbroken by a ripple, and "shone in the sun like burnished silver."

A notion prevails that earthquakes are always preceded by unusual conditions of the atmosphere, but careful observations have shown that they occur during all kinds of weather. The Lisbon earthquake,

FIG. 7.



FORT OF SINDREE, ON THE EASTERN BRANCH OF THE INDUS, BEFORE IT WAS SUBMERGED BY THE EARTHQUAKE OF 1819.

which took place in the morning of the 1st of November, was preceded by a "period of clear autumnal weather," but the morning was calm, foggy, and warm. At Arica, as we have learned, the sky was serene and the atmosphere tranquil. Some of the greatest convulsions have been preceded by a close, hazy sky. Sir Charles Lyell observes that "irregularities in the seasons frequently precede and follow shocks. Sudden gusts of wind interrupted by dead calms, violent rains at unusual seasons, or in countries where they seldom occur, are phenomena often attending earthquakes."

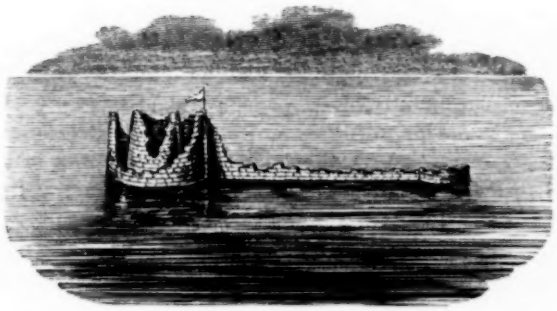
The number of important earthquakes up to the year 1861, of which we have a reliable account, is, according to Prof. Ansted, 7,000. So meagre are early records that only 787 of these are spoken of previous to the year 1500. There is a catalogue of 3,340 which occurred from

1800 to 1850, or one in about five days. The means of detecting and recording shocks are now so perfected, that, when applied in all parts of the globe, they will, doubtless, fully justify our statement that in no instant of time is the earth's crust free from vibrations. The seismograph is an instrument for the "automatic registration of earthquake-shocks."

An interesting account of this instrument, by George Forbes, was published in the September number of THE POPULAR SCIENCE MONTHLY.

Earthquakes have been defined to be a "travelling zone of vibration." The movement is in every direction from the area of disturbance, and the velocity depends on the substance and structure of the material through which it is transmitted. In New Zealand, in 1848, people on the shore witnessed the disastrous progress of the earthquake along the mountains before they felt the shocks. At Messina, during the Calabrian earthquake, the terrified inhabitants saw villas overthrown upon the coast by shocks which they had not felt, but which in a moment laid in ruins a portion of their own city. The velocity with

FIG. 8.



VIEW OF THE FORT OF SINDREE FROM THE WEST, IN MARCH, 1838.

which the vibrations travel has been a subject of careful investigation. The Lisbon earthquake moved about 20 miles in a minute; that which occurred in 1819, in the delta of the Indus, appears to have moved at the rate of 53 miles in a minute, or nearly 5,000 feet in a second. Other observations show that the movement may be from 1,000 to 5,000 feet per second. It has been ascertained that in blasting rocks the vibrations move in a second from 1,000 to 1,700 feet. The sound-waves move more rapidly, and, for this reason, shocks are usually preceded by subterranean rumbling. The velocity of sound through uniform strata is ascertained to be from 8,000 to 10,000 feet in a second. Tyndall found that sound-waves moved through burnt clay nearly ten times more rapidly than through air at a temperature of 32° Fahr. From this the phenomena of earthquake movement might

occur in the following order: Supposing the centre of the disturbance to be beneath the ocean, as at Lisbon, an observer on the shore might expect to experience—

1. The underground rumble, moving at the rate of 8,000 to 10,000 feet per second.

2. The shock, moving from 1,000 to 5,000 feet per second.

3. The sea-wave, moving about 528 feet per second.

4. Sound, through the air moving at the rate of 1,090 feet per second. It should be noted, however, that the velocity of the sea-wave depends on *depth* of water.

The vibrations of an earthquake, it is evident, differ in no respect from those produced by other causes, excepting in intensity. The jar arising from a discharge of artillery, by a carriage rolling over pavements, or slamming of heavy doors, puts in motion a series of moving waves just as truly as does the rending of rocks, or an explosion of steam or gas in a fracture thus produced. But, a question arises, What moves when the earthquake is progressing. The phenomena may be explained thus: Around the source of disturbance the rock is pressed outward in every direction as air is pressed outward around a vibrating bell, forming what is called a zone or shell of compressed rock. The extent of this compression is the width of the earthquake-wave, and depends on the force exerted and the elasticity of the rock. In each zone or shell there is always a point of maximum density—and that is where the energy of compression and the rock's elastic force are equal.

As the wave passes, another zone is formed, and the particles behind return by their elasticity to their former position. From this it is obvious that, as the wave is passing, the individual particles of the rock have first a forward and then a backward motion—a swing or excursion to and fro. The extent of this motion is the amplitude of vibration, and may be very small compared with the breadth of the wave.

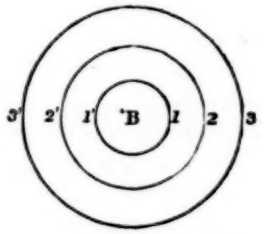
Mallet found by computation that, given a certain depth of fissure, and a certain heat of steam, the expansive force would produce a wave of nine inches amplitude at the surface. His observations of the Neapolitan earthquake of 1857 show that the maximum amplitude at the surface was only 2.5 inches. In his elaborate and beautiful volume on the eruption of Vesuvius, in 1872, just published, Mr. Mallet reaffirms a statement previously made by him, that "it is the vibration of the wave itself, i. e., the motion of the wave-particles, that does the mischief, *not* the transit of the wave from place to place on the surface."

We understand, then, that there is motion of particles as well as a transit-wave; that the "travelling zone or shell of vibration" is a zone or shell of "elastic compression."

Fig. 9 illustrates the "shells" as they move away from B, the focus of disturbance. The transit-wave, with its interstitial vibrations, reaches the surface in the manner shown in the diagram Fig. 10.

The diagram shows the waves radiating from the earthquake focus A to *c d e f* and *g* successively, and reaching the surface at B, where the shocks would be vertical. At 1 2 3 they become more and more oblique, and at greater distances appear almost horizontal.

FIG. 9.



CONTINUOUS WAVES FROM A SINGLE SHOCK.

Now, while the movement of the transit-wave may be very rapid, that of the particles of matter is surprisingly small. At Lisbon the velocity of the wave was 20 miles a minute, or 1,200 miles an hour. According to Mallet, where the velocity of the transit wave was 1,000

FIG. 10.

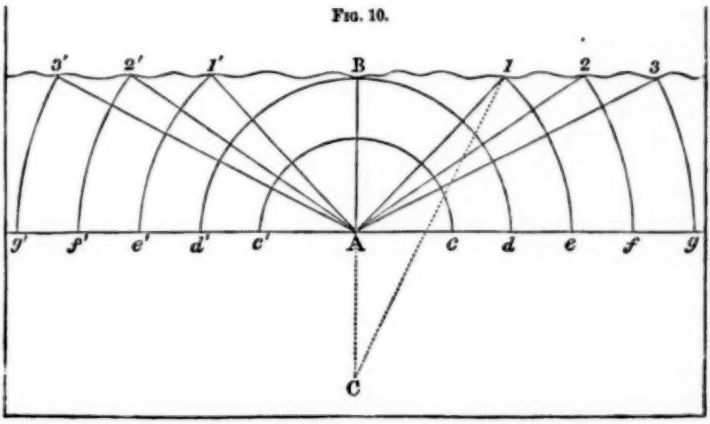


DIAGRAM SHOWING THE MOVEMENT OF WAVES FROM THE CENTRE OR FOCUS.
B, point where the shocks would be vertical. 1 2 3 and 1' 2' 3' are points where the waves would reach the surface.

feet per second, the movement of the particles was only 12 feet per second, or eight miles an hour, and he states that three columns of the Temple of Serapis, on the shore of the Bay of Baiæ (*see* frontispiece), a region subject to earthquake-shocks, would be overthrown by a shock "whose wave-particles had an horizontal velocity of 3½ feet per second." The shock which threw human beings 100 feet in the air, at Riobamba, must have had a velocity of 80 feet per second. The theory of Mr.

Hopkins, published in 1847, was that the disastrous results of earthquakes were caused by the velocity of the wave of translation, and that theory is probably accepted by many who will distrust the conclusions of Mr. Mallet. But it is obvious to every observer that the enormous velocity of 1,200 miles an hour is not communicated to objects on the surface as the wave passes. They are rarely thrown to any considerable distance. Buildings are overthrown, but they fall where they stood.

We have already remarked that objects standing directly on the uniform strata are seldom injured by earthquake-shocks. Such was the case, as we have seen, with that portion of Lisbon which was built on the limestone and basalt. But where the surface, perhaps hundreds of feet deep, is of loose unelastic material, the transit-wave, *with its vibrations*, in passing through it, becomes broken into oscillations, its force is dissipated and motion reduced, but the vibratory swing which it communicates is sufficient to fissure the earth's surface and strew it with ruins.

On the coast of Dublin Bay, Mallet exploded gunpowder buried several feet beneath the surface, in the sand, and ascertained the intensity and velocity of the shock by a delicate seismometer. Other experiments gave the rate and intensity of movement in more compact formations with the following results: In sand, 824.9 feet in a second; in divided granite, 1,306.4 feet; in compact granite, 1,664.6 feet. It is found by observation that objects, as walls and chimneys, fall backward or forward, but generally in a line with the direction in which the wave travels, while fractures of walls occur in a line transverse to the direction of the wave. And by diagram, Fig. 10, it will be obvious that, given the position of the ruins over an extended area, not only the centre but depth of disturbance may be ascertained. If the focus be C, as shown in the diagram, the wave would reach the surface at an angle other than if the focus be at A, and the result would appear in the manner of displacement on the surface. By the principle here indicated, Mallet was able to locate the central area and depth of the Neapolitan earthquake of 1857, and states that the great fissure, the forming of which caused the first shock, was 7½ miles in length, and 5¾ miles in average depth.

The filling of the fissure with water, and its conversion into superheated steam, may have produced the subsequent shocks. By calculation, the same author shows the enormous pressure and rending power of steam if admitted without limit into such a fissure. "If the temperature increase 1° Fahr. for 60 feet depth, then, at the focal centre of the fissure, the temperature would be 883.4° Fahr., and the pressure on the walls of the cavity not less than 640,528,000,000 tons. But the pressure would be vastly increased if the temperature be near that of melted rock." That this may be the case is rendered probable from recent investigations of Mallet, by which he shows that the heat

which melts the great lava-beds, and fills cavities in the earth's crust with steam and gases, may not arise directly from the earth's central heat, but from the crushing of strata as it contracts and settles upon the cooling interior.

By a series of experiments and observations made by Mr. Mallet, it is shown that the "annual loss of heat into space of our globe at present is equal to that which would liquefy, at 32° Fahr., about 777 cubic miles of ice; and this is the measuring unit for the amount of contraction of our globe now going on."

The amount of shrinking depends, therefore, on the amount of heat lost—a view long since insisted on by Prof. Dana; and this, according to Mallet, is sufficient to account for all the phenomena. To this cause, then, we refer the never-ending oscillations of the earth's cooled exterior, and the enormous lateral strain by which it is bent and fractured, and its broken ridges made to grind and crush with terrific vibrations.

In many areas the earthquake energies of former times have been long at rest, but, according to Sir Charles Lyell, the total energy may not have diminished.

He finds evidence of convulsions as great and obvious in recent as in earlier time. Mallet, however, remarks that "seismic energy may be considered as possibly constant during historic time, but is probably a decaying energy viewed in reference to much longer periods."

Everywhere we see, in exposed portions, crevices open or filled—ejections of trap and basalt; and wall-like dikes stand out upon the slopes of mountains. These are legible and significant chapters in the earth's dynamic history.

Do earthquakes occur with any order or system, so that their coming may be foretold?

Prof. Palmieri, in his observatory on Mount Vesuvius, is able, says George Forbes, "to predict eruptions." "This is a small eruption," remarked the professor, "but there is going to be a greater one; it may be a year hence, but it will come." "In almost exactly a year," continues Mr. Forbes, "the great eruption did come."

From Mallet's catalogue of European earthquakes it appears that, during 15½ centuries, 1,157 took place during the winter, against 875 in the summer months.

Although science has cleared up some of the mystery which hung over earthquakes in less enlightened times, it has not divested them of their sublimity and terrible reality.

Their work of destruction is done in a moment. The great battles of the world have scarcely been so destructive of human life.

We read that 250,000 persons perished during the earthquake at Antioch in 526. At Lisbon 60,000 people were destroyed. During one of the Calabrian earthquakes 35,000; and during the one at Arequipa in 1868, 40,000 persons perished. Pestilence, famine, and fire.

add to the fatality. Visitations so severe and disastrous permanently affect the inhabitants of earthquake regions. Their minds lose their calm equipoise—they become nervous, and the first considerable shock sends them to the street or cathedral for safety.

Humboldt remarks that, when "we feel the ground move beneath us, our deceptive faith in the repose of Nature vanishes, and we feel ourselves transferred into a realm of unknown and destructive forces. Every sound, the faintest motion of the air, arrests attention. To man, the earthquake conveys the idea of unlimited danger." And Von Tschudi adds his testimony, that "no familiarity with earthquakes can blunt this feeling of insecurity. The traveller from the north of Europe waits with impatience to feel the movement of the earth, and with his own ear to listen to the subterranean sounds, but, soon as his wish is gratified, he is terror-stricken, and is prompted to seek safety in flight." Thus it is that physical phenomena aid in moulding the mental and moral character of a people. The earthquake records itself, not only on the inorganic world, but in man's spiritual nature.

ELECTRICITY AND LIFE.

By FERNAND PAPILLON.

TRANSLATED BY A. R. MACDONOUGH, ESQ.

GALVANI discovered, in 1794, that the muscles of animals experience contractions in contact with certain metals. In his view, this contact merely calls out the discharge of a fluid inherent in the animals themselves. The fact was not to be contested, but its explanation was. Lively discussions in the schools of physiology followed—fortunately, with a clear understanding that the difficulty could only be determined by experiments. A vast number were made, the name of Volta being connected with the most remarkable of them. Alexander Volta maintained, in opposition to Galvani, that the electricity which produces contractions in the muscles, far from originating in those organs, is introduced by the metals used in the process. In proof of this he constructed, in 1800, the pile that bears his name, and which is an arrangement in which the connection of two different metals becomes an abundant source of the electric fluid. Galvani and Volta were two men of distinguished genius, who thoroughly understood physics and physiology, and advanced nothing heedlessly. Their discoveries were the point of departure for one of the most admirable movements in all the history of science, a movement which is still most active, and is the more remarkable because it resulted but yesterday, as it were, in the complete demonstration that Galvani and Volta were both in the right. Science to-day proves that there is an elec-

tricity peculiar to animals, as Galvani declared. It decides also that electricity produced by external causes has an influence over animals, as Volta taught. From profound study of the two orders of phenomena, it deduces a system of procedure for the cure of very many maladies by electricity. Consequently, an exposition of the relations between electricity and life must begin with examining the electricity that exists naturally, in the same way that heat does in animals, and then go on to explain the action of the fluid on the organism, whether in a healthy or a morbid state. Such a description will complete what has been written in the *Review* respecting the relations of life with light and heat—relations that we may to-day consider as forming the features of a new science.

I.

The most authentic witnesses to the existence of animal electricity are fish. The torpedo, the silurus, the gymnotus, the ray, and other fishes, develop spontaneously a more or less considerable quantity of electricity. This fluid, the production of which depends upon the animal's will, is identical with that of common electrical machines; it gives the like shocks and sparks at a certain tension. The apparatus for its formation consists of a series of small disks of a peculiar substance, kept apart by cells of laminated tissue. Fine nerve-end fibres are scattered over the surface of these disks, and the whole represents a sort of membranous pile, usually placed in the region of the head, sometimes toward the tail.

These fishes are the only animals provided with an apparatus specially devoted to the production of electricity; but all animals are electric, in this sense, that a certain quantity of that fluid is constantly forming within their organs. The existence of electricity peculiar to the nerves and muscles, and independent of their special modes of action, has been settled by numerous experiments, particularly by those of Nobili, Matteucci, and Dubois-Reymond. To prove the currents of nervous electricity, it is sufficient to prepare a frog's muscle, and touch it at two different points with the two ends of a nerve-filament of the same animal. The muscle then undergoes contraction under the influence of the nervous current. Another experiment, as simple, proves the existence of the muscular current. In an animal living or just killed, a muscle is exposed and cuts made in it perpendicularly to the course of the fleshy fibres, and communication effected by the two wires of a very sensitive galvanoscope between the natural surface of the muscle and the surface made by incision. The needle of the instrument then betrays the passage of a current. This muscular electricity may be obtained in tolerable quantity by placing a number of slices of muscle together in the form of a pile. The positive pole of the system will be the natural surface of one of the terminal slices, and the negative pole the cut surface of the other. Such a battery acts

upon galvanic instruments, and can even excite contractions in other muscles.

Independent of these nervous and muscular electric currents, other sources of this fluid exist in the animal economy. Currents are produced between the outer and inner surfaces of the skin, in the blood, in the secreting vessels—in fine, almost throughout the whole organism. The experiments, as delicate as original, to which Becquerel has for several years devoted all the activity of his green old age, authorizes him now to assert the preponderance of electro-capillary phenomena in animal life. According to this accomplished physicist, two solutions of different nature, both conductors of electricity, separated by a membrane or a capillary space, compose an electro-chemic circuit; and, if we reflect on the anatomical elements of the various tissues, cells, tubes, globules, etc., in their connections with the fluids that moisten them, we find that they give rise to an infinite number of pairs constantly evolving electricity. The blood of the arteries with that of the veins forms a pair, having an electro-motive power of 0.57, that of a pair with nitric acid being 100. Becquerel explains, by the intervention of these currents, many physiological phenomena hitherto imperfectly understood. Granting the reality of such actions, yet it must be acknowledged that the general doctrine which combines them each with the other, and links the whole together with the various modes of action of the organism, is far from being clear and precise. We need to know how these currents are distributed and circulate, what lines and courses they follow. It is now time for experimental physiology to attack these difficult problems, the solution of which is absolutely necessary for accurate knowledge of vital determinations, that is, for the computation and the estimate of those various factors which are terms in all the equations of organic movement.

Vegetables, too, develop electricity. Pouillet has clearly demonstrated that vegetation throws it off. Other physicists, particularly Becquerel, have proved the existence of currents in the fruits, stems, roots, and leaves of plants. Becquerel took a branch of young poplar full of sap, introduced a platinum wire into the wood and another into the bark, and brought the two ends of the conductors together in a galvanoscope—the needle at once showed the passage of a current. Buff has lately made experiments, taking care not to injure the organs. Two vessels containing mercury receive platinum wires; over the mercury stood water containing the vegetables to be examined as to their electric condition. Taking the leaves and roots, Buff proved a current passing through the plant from the roots to the leaves; in a branch severed from the stem the current passed toward the leaves, too. To sum up, the existence of vital electricity is incontestable, though we do not yet precisely understand the conditions of this internal excitement, and know nothing of its true relations with the unity of physico-chemical operations in the living organism.

The latter are, at all events, exceedingly complex. There is in us, and in every organized being, an infinite world of the most various actions going on. The forces penetrating us are as manifold as the materials we are moulded from. In every point of our bodies, and at every moment of our existence, all the energies of Nature meet and unite. Yet, such order rules in the course of these wonderful workings, that harmonious blended action, instead of bewildering confusion, characterizes beings endowed with life. Every thing in them commands and answers, with balance and counterpoise. Buffon long ago felt and expressed this. "The animal," he said, "combines all the forces of Nature: his individuality is a centre to which every thing is referred, a point reflecting the whole universe, a world in little." A deep saying, coming from the great naturalist as the flash of an intuition of genius, rather than the result of rigid investigation—words which the movement of science confirms with ever stronger proofs, while borrowing from them light for its path.

Having determined that living bodies are in themselves sources of the electric fluid, we next inquire into the nature of the effects produced in the animal organism by electricity under different forms. The atmosphere contains a variable quantity of positive electricity; the earth itself is always charged with negative electricity. It is not yet precisely known how this diffused and silent force originates. Physicists suppose that it proceeds from vegetation and the evaporation of water. Becquerel has quite lately set forth a number of reasons, more or less plausible, for the belief that the chief part of atmospheric electricity is derived from the sun, and diffused by it into space together with light. Whether this be true or not, while the sky is clear this fluid has no visible effect on human beings; but, whenever it accumulates in the clouds, and gives rise to storms, it produces effects that are the most manifest proofs of the influence exerted over life by electricity. Persons killed by lightning present a great variety of appearances. Sometimes one struck by lightning is killed outright on the spot, the body remaining standing or sitting; sometimes, on the contrary, it is thrown to a great distance. Sometimes the flash tears off and destroys the victim's dress, leaving the body untouched, and sometimes the reverse is the case. In some instances the destruction is frightful, the heart is torn apart and the bones crushed; in others the organs are observed entirely uninjured. In certain cases flaccidity of the limbs occurs, softening of the bones, collapse of the lungs; in others, contractions and rigidity are remarked. Sometimes the body of the person struck decomposes rapidly, but at times it resists decay. Lightning, which shatters trees and overturns walls, seems not to produce mutilations in animals at all readily. When the stroke does not produce death, it creates at least serious disturbances—sometimes temporary, but oftener beyond remedy. Besides the burns and various eruptions noticed on the skin of those struck with lightning, they often

suffer, very curiously, a complete loss of hair; they are affected with paralysis, dumbness, deafness, amaurosis, or imbecility. In brief, the destructive attacks of atmospheric electricity touch all the functions of the nervous system.

The action of electric fishes may be likened to that of lightning, in being independent of our intention. The shocks of the gymnotus are particularly formidable. Alexander Humboldt relates that, having put both his feet on one of these fish, just taken from the water, he experienced so violent a shock that he felt pains in all his joints the rest of the day. These shocks throw the strongest animals down, and it is necessary to avoid rivers frequented by the gymnotus, because, in attempting to ford them, horses or mules might be killed by the discharges. To capture these fish the Indians drive wild horses into the water, stirring the eels up out of the mud by their trampling. The yellowish livid creatures press against the horses under their bellies, throw down the greater part and kill some of them, but, exhausted in their turn, they are then easily taken with the aid of small harpoons. The savages employ them to cure paralysis. Faraday compares the shock of a gymnotus, which he had an opportunity to study, to that of a strong battery of fifteen jars. A live eel out of water, when touched by the hand, communicates a shock strong in proportion to the extent of surface in contact, and the stroke is felt up to the shoulder, and followed by a very unpleasant numbness. It may be transmitted through twenty persons in a chain, the first one touching the back, and the last the belly of the eel. The fishermen discover the presence of an eel in their nets by experiencing a shock in throwing pailfuls of water on, to wash them. Water is a good conductor, and this fish kills or benumbs the animals it feeds on by delivering a discharge through the water.

Other sources of electricity are known to exist, besides thunderstorms and fishes. Friction-machines, batteries, and induction instruments, yield three kinds of currents that act on vital functions, sometimes in a similar way, but oftener with marked differences, which have only recently been clearly distinguished. The action of static electricity, and that of electricity of induction, more sudden and violent, is particularly marked by mechanical effects so striking that they have long distracted experimenters from examining with due attention those effects of another sort, produced by the galvanic current. Yet, the latter in reality affects the animal tissues in a deeper way, and its resulting phenomena deserve the liveliest interest from a theoretical point of view, as well as from their applied uses.

Dutrochet proved, by remarkable experiments, that, when a tube closed below by a membrane, and containing gum-water, is placed in a vessel containing pure water, the level of the gum-water rises little by little through the gradual introduction of pure water into the tube, while a certain quantity of the gum-water inside mingles with the

pure water outside. In a word, a mutual exchange takes place between these two fluids, communicating by the membrane, and the current, passing from the thinner liquid toward the denser one, is ascertained to be more rapid than that moving in the opposite direction.

This experiment reveals one of the most important phenomena of life in plants and animals, noted by the word endosmosis. Now, Dutrochet had before observed that if the positive pole of a battery be inserted in the pure water, and the negative pole in the gum-water, the acts of endosmosis are effected more energetically. Onimus and Legros discovered further, that, if the contrary arrangement be adopted, that is, if the positive pole be placed in the gum-water, and the negative pole in the pure, the level of the liquid in the tube descends noticeably, instead of rising. Electricity, therefore, can reverse the usual laws of endosmosis. It exerts an influence not less distinct on all the other physico-chemical movements, taking place deep in the organs. In them it decomposes the salts, coagulates the albuminoid elements of the blood and the tissues, just as it does in the vessels of the laboratory. Take a very curious instance: In chemistry, on decomposing the iodide of potassium, iodine is freed, and betrays itself by the tinge of intense blue which it develops on contact with starch. Now, if an animal be injected with a solution of iodide of potassium, and then electrified, it is noticed, after a few minutes, that all the parts near the positive pole of the battery turn blue in presence of the starch, proving that they are impregnated with iodine. The iodide has been almost instantly decomposed, and the iodine carried by the current toward the positive pole.

It is not surprising, then, that the action of electricity influences the whole system of the nutritive operations. Onimus and Legros found that ascending continuous currents quicken the twofold movement of assimilation and diassimilation. Animals electrified under certain conditions throw off a greater proportion of urea and carbonic acid, proving a higher energy of the vital fire. On the other hand, if young individuals, in growing development, are subjected to the action of the current, they grow tall and large more quickly than in ordinary circumstances, furnishing the proof of an increase in the quantity of substances assimilated. To show how far vital phenomena are stimulated by electricity, we will cite another experiment made by Robin and Legros on noctilucæ. These are microscopic animals, which, when existing in great numbers in sea-water, render it almost as white as milk, and at certain times phosphorescent. Now, a current, directed into a vessel filled with such water, suffices to bring out a trace of light marking all its course. Electricity stimulates the phosphorescence of all the noctilucæ met on its passage between the two poles.

Interrupted currents, or currents of induction, contract the blood-

vessels and slacken the circulation in almost every case: if they are intense, they even effect its complete check by a strong contraction of the little arterial branches. Continuous currents do not act in this way; usually they quicken the circulation, while occasioning an enlargement of the vessels, at least, this has been established by Robin and Hiffelsheim, in the microscopic examination of the flow of blood under electric stimulus. Onimus and Legros afterward proved that these movements are governed by the following law: The descending current dilates the vessels, and the ascending current contracts them. A striking experiment proves the value of this law: A part of the skull of a vigorous dog is removed, so as to expose the brain. The positive pole of a pretty strong battery is then placed on the exposed brain, and the negative pole on the neck. The slender and superficial vessels of the brain contract visibly, and the organ itself seems to collapse. Arranging the poles in the contrary order, the reverse is remarked; the capillary vessels swell and distend, while the substance of the brain protrudes through the opening made in the walls of the skull. This experiment proves the possibility of increasing or lessening at will the intensity of circulation in the brain, as indeed in any other organ, by means of electric currents. Onimus lately made an equally interesting experiment. Many persons know that the famous physiologist Helmholz introduced into medicine the use of a simple and convenient instrument called the ophthalmoscope, by means of which the bottom of the eye may be quite distinctly seen, that is to say, the net formed by the nerve-fibres, and the delicate vessels of the retina. Now, on examining this net, while the head is put under electric influence, the little blood-tubes are plainly seen to dilate and grow of a more lively crimson.

Let us now study the effect of the electric current on the functions of the motor system, and on sensibility. Aldini, a nephew of Galvani, undertook the first investigations of this kind upon human beings. Convinced that the proper study of the effects of electricity on the organs required the human body to be taken at the immediate instant after the extinction of life, he believed he would do well, as he relates himself, to take his place beside the scaffold, and under the axe of the law, to receive from the executioner's hand the blood-stained bodies which were the only really suitable subjects for his experiments. In January and February, 1802, he availed himself of the occasion of the beheading at Boulogne of two criminals, whom the government willingly gave up to his scientific inquiry. Subjected to electric action, these bodies presented so strange a sight as to terrify some of the assistants. The muscles of the face contracted in frightful grimaces. All the limbs were seized with violent convulsions. The bodies seemed to feel the first stir of resurrection, and an impulse to spring up. For several hours after decapitation, the vital centres of movement retained the power of answering to the electric excite-

ment. At Glasgow, Ure made some equally noted experiments on the body of a criminal, which had remained on the gallows nearly an hour. One of the poles of a battery of 270 pairs having been connected with the spinal marrow, below the nape of the neck, and the other pole touching the heel, the leg, until then bent back, was forcibly thrown forward, almost oversetting one of the assistants, who had a strong hold on it. Placing one of the poles on the seventh rib, and the other on one of the nerves of the neck, the chest rose and fell, and the abdomen underwent the like motion, as in the act of breathing. On touching a nerve of the eyelid at the same time with the heel, the muscles of the face contracted, "rage, horror, despair, anguish, and fearful grins, combined in hideous expressions on the dead man's face." At the terrible sight one person fainted, and several were obliged to leave the room. Afterward, by exciting convulsive movements of the arms and fingers, the corpse was made to seem to point at one or another of the spectators.

Later researches have precisely fixed the conditions of this influence of electricity upon the muscles. Continuous currents, led directly to these organs, produce contractions at the moments of opening and of closing the circuits; but the shock produced on closing is always the strongest. While the continuous current is passing, the muscle remains persistently in a half-contracted state, as to the nature of which physiologists disagree. Influenced by excitements rapidly repeated and prolonged for a short time, the muscles assume a state of contraction and shortening, like that seen in tetanus. In this state, as Helmholz and Marey have shown, the muscle suffers a repetition of very slight shocks. Contraction is the result of the fusion of these elementary vibrations, indistinguishable by the eye, but capable of recognition and measurement by certain contrivances. Currents of induction produce more powerful contractions, but not lasting ones, which are succeeded, if electrization is prolonged, by corpse-like rigidity. Muscular contraction effected in such a case is attended by a local rise in temperature, proportioned to the force and length of the electric action. This increase of heat reaches its maximum, which may in some cases be four degrees, during the four or five minutes following the cessation of the electric impulse, and is due to the muscular contraction, which always gives rise to disengagement of heat.

The effect upon the nerves is very complex, and betrayed by movements and sensations very variable in intensity. Onimus and Legros state in general its fundamental laws thus: In acting on the nerves of motion, we see that the direct or descending current works more energetically than the other, with the reverse result on the nerves of sensation. The excitability of those nerves of a mixed kind is lessened by the direct and increased by the inverse current. This is true as to battery-currents, but currents of induction behave differently. While the sensation called out by the first is almost insignificant, the

others, besides the permanent muscular contraction, produce a pain lasting as long as the nerve retains its excitability. The spinal marrow is one of the most active parts of the system. In the form of a thick, whitish cord, lodged inside the vertebral column, it constitutes a real prolongation of the brain, of which, under some circumstances, it takes the place. The unconscious depositary of a part of the force animating the limbs, by means of the nerves sent out from it, it transmits to them their direction and power to move, while the brain is unaware of its action. This takes place in what are called reflex motions, and these occur in beheaded animals, through the simple excitement, direct or indirect, of the spinal marrow. Experiments may be cited, showing the action of electricity on those phenomena which have their seat in the spinal marrow. If a frog is plunged into lukewarm water, at a temperature of 40°, it loses respiration, feeling, and motion, and would die if kept in it a long time. When taken out of the water, and placed in this state under the action of the current, it contracts strongly when its vertebral column is electrified by an ascending charge; but no motion follows if the descending current is applied. On the other hand, if the latter is sent into a beheaded animal, stimulated to reflex motions, by the excitement of the spine, it tends, as experiment shows, to paralyze these motions. In general, this is the law discovered by Onimus and Legros—the ascending battery-current, directed on the spine, increases the excitability of that organ, and consequently its power of producing reflex phenomena; the descending current, on the contrary, acts in the reverse way.

When the brain of animals is directly electrified, the modifications in circulation already spoken of result, but no special phenomena are observed. The animal shows no pain, and makes no movement, experiencing a tendency toward sleep, a sort of calm and stupor. Some physicians have gone so far as to propose electrization of the brain as a means of developing and perfecting the mental powers. Nothing hitherto justifies the belief that such a course could have the slightest influence for good over the functions of thought. On the contrary, it is very certain that the electric agent must be applied only with extreme caution to the regions of the head, and that it very easily occasions mischief in them. A strong current might readily cause rupture of the vessels, and dangerous hæmorrhage in consequence.

Again, electricity stimulates all the organs of sense. Directed upon the retina, it excites it, producing sensations of glare and dazzling. When sent through the organ of hearing, it produces there a peculiar buzzing noise, and, if brought in contact with the tongue, it calls forth a very characteristic metallic and styptic sensation. And in the olfactory mucous membrane it creates a sneezing irritation, and also, it seems, an odor of ammonia.

The currents not only act on the cerebro-spinal nerves, and the muscles concerned in life, as related outwardly, but affect also the parts

of the nervous and muscular systems devoted to the functions of nutritive life. Electricity by induction, applied to these muscles, causes contraction in them at the point of contact with the poles, while the part situated between the poles remains without motion. Continuous currents produce, at the instant of closing the circuit, a local contraction at the junction with the poles, and then the organ becomes quiet; if it is previously in action, motion ceases. In the case of the intestine, for instance, peristaltic movement is checked; and by means of electricity contractions of the uterus may be suspended in an animal, during parturition. In general, the fluid suppresses spasms of all the involuntary muscles.

All these facts relating to electric action upon the muscles and nerves have been the occasion, particularly in Germany, of laborious investigations, with which are connected the names of Dubois-Reymond, Pflüger, and Remak. The doctrines of these learned physiologists, regarding the molecular condition of the nerves in their various modes of electrization, are still very much disputed. It must be said that they are not supported by any experimental certainty, and perhaps the ideas developed by Matteucci supply better means for the general solution of these difficulties. This eminent experimenter opposed, to the German theories about the electrotonic faculties of the nerves, certain evident phenomena of electrolysis, that is, of chemical decompositions effected by the currents. He supposed that the modifications of excitement in the nerves, brought about by the passage of electricity, depended on the acids and the alkalies resulting from the separation of the salts contained in animal tissues. To this first class of phenomena may be added those electro-capillary currents lately observed by Becquerel. Here must be sought the deeper causes of that complicated and as yet obscure mechanism of the strife between electricity and life.

The effects of electricity on plants have been much less studied, experiments made on this subject being neither accurate nor numerous enough. We know that electricity causes contractions in the various species of mimosa, particularly in the sensitive-plant, that it checks the flow of sap in certain plants, etc. Becquerel has studied its action on the germination and development of vegetables. Electricity decomposes the salts contained in the seed, conveying the acid elements to the positive pole, and the alkaline ones to the negative. Now, the former injure vegetation, while the latter benefit it. Quite lately, the same experimenter has made a series of researches upon the influence of electricity on vegetable colors. Employing strong discharges obtained from friction-machines, he has noticed very remarkable alterations of color, usually due to the rupture of the cells containing the coloring-matter of the petals. This matter, freed from its cellular covering, disappears on simply washing with water, and the flower becomes almost white. In leaves showing two surfaces of dif-

ferent shades, as the *begonia discolor*, a kind of mutual exchange of colors between the two surfaces has been noticed.

II.

The physiological phenomena just spoken of are usually confounded in books with the facts of electric medical treatment, and it seems better to distinguish the two classes. The true method consists in first explaining the phenomena displayed in the healthy organism, as the only way of understanding afterward those that are peculiar to disorders. Electric treatment forms a group of methods to be classed among the most efficacious in medicine, provided they are applied by a practitioner well trained in the theory of his art. Indeed, the most thorough physiological knowledge is essential for the physician who would make the electric current serviceable. Mere experimenting, even the most sagacious, must here be barren of good results—a fact of which it is well to remind those who impute to the method itself the failures it meets with in unskilful hands. It is true that, since the days of Galvani and Volta, physicians have used galvanism in the treatment of many diseases. Early in the century, galvanic medicine was much talked of, and supposed to be the universal panacea. Galvanic societies, journals, and treatises, undertook to spread its usefulness. The fashion lasted a certain time, and would perhaps have grown indifferent, when the discovery of induced electricity, due to Faraday, in 1832, called professional attention once more to the virtues of the electric fluid, and led to a new and interesting range of experiments. Yet it is likely that the true systems of electric medical treatment, after the extraordinary illusions of their earlier days had vanished, would at length have sunk into disuse, had they not escaped from the ruts of empiricism. With its usual boldness, it had at first gained them a high rank, which it had no power to maintain. It was experimental physiology, with its exact analysis of the mechanical effects of this fluid upon the springs of the organism, which made its application in the healing art sure, true, and solid, as it now is. In this, as in all things, blind art has been the impulse to scientific research, which in turn steadily enlightens and perfects art.

It is singular that induction-currents have met with much better fortune than galvanic ones. The latter, the use of which introduced electric treatment, have gained real importance in physiology and medicine only within a few years, and after the reputation of induction-currents was well established, thanks chiefly to the efforts of Duchenne. A German physiologist and anatomist, Remak, who died six years ago, was the first to urge the singular remedial virtues of the voltaic current. Remak, after devoting twenty years to the study of the most difficult questions in embryology and histology, undertook, in 1854, the systematic examination and ascertainment of the action of continuous currents on the vital economy. He soon

gained remarkable dexterity in dealing with the electric agent, and detecting with the readiest insight the proper points for applying the battery-poles in each malady. Those who, with us, witnessed in 1864 his practice at the hospital, will remember it clearly. The methods of Duchenne were almost the only ones accepted in practice in France, till Remak came to prove to Paris physicians the powers of electrization by constant currents, in cases where Faraday's currents had been without effect. The teaching of the Berlin practitioner bore its fruits. A rising young physician, Hiffelsheim, was beginning to spread throughout Paris the use of the constant current as a healing agent, when death removed him in 1866, in the flower of his age. Another physician, who benefited by the lessons of Remak, Onimus, resumed the interrupted labors of Hiffelsheim, and is now busy in completing the system of the methods of electric medical practice, by subjecting them to an exact knowledge of electro-physiological laws. A few instances, from the mass of facts published on the subject, will serve to show how far the efficiency of these methods has actually been carried.

Experiment proves that, under certain conditions, the electric current contracts the vessels, and thus checks the flow of blood into the organs. Now, a great number of disorders are marked by too rapid a flow of blood, by what are known as congestions. Some forms of delirium and brain-excitement, as also many hallucinations of the different senses, are thus marked, and these are entirely cured by the application of the electric current to the head. No organ possesses a vascular system so delicate and complex as the brain's, nor is there any so sensitive to the action of causes that modify the circulation. For this reason, disorders seated in the brain are peculiarly amenable to electric treatment, and, when carefully applied, it is remedial in brain-fevers, mental delirium, headaches, and sleeplessness. Physicians who first employed the current were quite aware of this benign influence of the galvanic fluid over brain-disorders, and even had the idea of utilizing it in the treatment of insanity. Experiments in that direction have not been continued, but the facts published by Hiffelsheim justify the belief that they would not be barren. These facts testify to the benefits that electric currents (we mean only continuous ones) may some day yield in brain-diseases—a point worth the attention of physicians for the insane. Till lately it was thought that electricity was a powerful stimulant only, but what is true of interrupted currents is not true as to currents from the battery. Far from being always a stimulant, the latter may become in certain cases, as Hiffelsheim maintained, a sedative and calming agent. This control over circulation, joined with the electrolytic power of the galvanic current, allows its employment in the treatment of various kinds of congestions. A congested state of the lymphatic ganglia, the parotid glands, etc., may be relieved by this means, the current acting in such cases

both on the contractility of the vessels, and the composition of the humors.

In cases of paralysis, more than any others, electricity displays all its healing power. Paralysis occurs whenever the motor nerves are separated from the nervous centres by any injuring cause, or by any modification of texture impairing their sensitiveness. With a destroyed nerve, paralysis is incurable, but, in case of its disease only, its functions can almost always be restored by electric treatment. As there is always some degree of muscular atrophy in the case, electricity is directed upon the nerves and the muscles at once, and the battery and the induction current usually employed together. As a rule, the first modifies the general nutrition, and restores nervous excitability, while the last stimulates the contractile power of the muscular fibres. The difference of action between the two kinds of currents is clear in certain paralyses, in which the muscles show no contraction under induction-currents, while under the influence of constant currents they contract better than the uninjured muscles. Experiments made some years ago in Robin's laboratory, on the bodies of criminals executed, proved that, after death, muscular contraction can still be produced by Volta's currents, though Faraday's current has no such effect.

When the motor nerves are in a state of morbid excitement, they compel either muscular contractions that are lasting, as tonic spasms, or intermittent ones. The different motor nerves most commonly excited are the facial nerves, the nervous branches of the forearm or the fingers, which are affected in "writer's cramp," and the branches of the spinal nerve, whose irritation occasions tic-douloureux, chronic wryneck, etc. Now, electricity cures, or at least noticeably benefits these different morbid states, and exerts the like influence over neuralgic and neuritic affections, wherever these disorders are not the symptoms of other deeper maladies. Currents restore the normal activity of nutrition in the diseased nerves, and the corresponding muscles; they act on rheumatism, too, in the most beneficial way, modifying the local circulation, quieting the pain, and stimulating reflex phenomena, which are followed by muscular contractions. Erb, Remak, Hiffelsheim, and Onimus, have proved beyond question this salutary action on swellings of the joints, either in acute or chronic cases.

The discoveries respecting the influence of electricity over the spinal marrow have been used with advantage in the treatment of such disorders as arise from unduly-excited activity in this organ, such as chorea, St. Vitus's dance, hysteria, and other nervous convulsions, more or less similar. We cite two instances of this sort published by Dr. Onimus, giving an idea of the mode of applying the current in such cases. A child, twelve years old, was seized with a frightful attack. Every five or six minutes it lost consciousness, rolled on the ground, its eyes turned upward, then grew so rigid that none

of its limbs could be bent. The attack over, it regained its senses, but the least impression, at all vivid, sufficed to bring on a new attack. Ascending currents were first applied to the spinal marrow. The child was at once seized with a violent crisis. Descending currents were then used for fifteen days in succession, after which the little patient regained health. A young girl aged seventeen, in an hysteric condition, presented very strange symptoms in the larynx, the velum of the palate, and the facial muscles, among others a sort of barking, followed by vehement sniffing and horrible grimaces. By placing the positive pole in the patient's mouth against the arch of the palate, and the negative pole on the nape of the neck, all these morbid affections were completely subdued. The disposition of the poles in the reverse order, on the other hand, aggravated them. After sixteen repetitions of electric treatment, the young girl was almost completely cured, retaining only a muscular twitch of little importance, compared with her former ailments. Several cases of tetanus also were treated with complete success by similar methods. This terrible disease, the most fearful of all surgical complications, is due to an acute inflammation of the spinal marrow. It is followed by such an alteration of the motor nerves, that all the muscles of the body experience general contraction, and a painful rigidity that by degrees attacks the vitally essential organs. When an attack of this kind reaches the muscles of the chest and heart, death occurs, through asphyxia. In such a case the continuous current restores the motor nerves to their normal state. Two other chronic diseases of the spine, the first being particularly serious—progressive muscular atrophy and locomotive ataxy—often yield to the rational use of electricity, or at least are checked in their progress, the natural issue of which is death. It is worth remarking that these two disorders were discovered and described by Duchenne, in the course of his researches into this method of treatment. Electricity served his purposes of diagnosis, as it serves in physiology as a means of study, taking in that science the place of a kind of reactive agent, and revealing functional differences that no other process could have detected. To it alone, according to the way in which it affects a nerve or a muscle, belongs the power, under certain circumstances, of determining the nature and even the degree of alteration in nervous or muscular elements.

Aldini said that galvanism afforded a powerful means of restoring vitality when suspended by any cause. Several physicians, at the beginning of this century, restored life by this means to dogs, after they had undergone all the processes of drowning, and seemed dead. Hallé and Sue proposed at that period to place galvanic machines in the different quarters of Paris, particularly near the Seine. This wise and useful plan has not yet been put into execution, though all experiments made since that time confirm the proof of the efficiency of electricity in cases of asphyxia and syncope, produced either by water or

by poisonous gases. The galvanic current also restores respiration in cases of poisoning by ether or chloroform, even when recovery seems hopeless. Surgeons who understand this effect, remember it whenever chloroform seems dangerous to the patient under its influence.

Electricity is transformed into heat with great ease. If an intense current is passed through a very short metallic wire, it heats, reddens, and sometimes vaporizes it. This property has been taken advantage of by surgeons for the removal of various morbid excrescences. They introduce a metallic blade at the base of the tumors or polypi to be extirpated, and when this kind of electric knife becomes incandescent, under the influence of the galvanic current, they give it such a movement that the diseased part is separated by cauterization, as neatly as with a cutting instrument. This method, which avoids effusion of blood, and is attended by only slight pain, has yielded excellent results in the hands of Marshall, Middeldorpf, Sédillot, and Amussat. Besides this application, in which heat plays the chief part, electricity has been used to destroy tumors, by a kind of chemical disorganization of their tissue. Crusell, Ciniselli, and Nélaton, have made decisive experiments of this nature. Pétrequin, Broca, and others, suggest the same method to coagulate the blood contained in sacs, in aneurisms. If this novel surgery is not so widely known and used as it deserves to be, the reason is that the manipulation of electric instruments requires much practice and dexterity, and surgeons find the classic use of the scalpel more convenient.

This rapid historical view shows that the method of treatment by electricity is useful in very many diseases. Whether resorted to to modify the nutritive condition, to quicken or check circulation in the small vessels, to calm or excite the nerves, to relax or stimulate the muscles, to burn or detach tumors, electricity, if managed rationally, is destined to do distinguished service in the healing art. The range of treatment by heat is less considerable, yet of some extent. The examination of the medical value of treatment by light has scarcely begun, nor has much been done toward the study of weight or pressure, in their relations to medical science. At all events, there is now forming and gaining increased development, alongside of the medicinal use of bodies, a medicinal use of forces—besides the physic of drugs, a physic of powers. It is impossible to say at present which of the two will definitely prevail—more probably both will be called on to render valuable services to art.

The first *savants* who studied the action of galvanic electricity on dead bodies, and saw them recover motion, and even an appearance of sensation, supposed they had touched the secret of life, likening to the vital principle that other force which seems to warm again the frozen organs, and restore their springs. Slight reflection on the facts collected in the foregoing pages reveals the thorough illusiveness of such a hope. Not only is electricity far from being the whole of life,

but it cannot even be regarded as one of the elements of life, or be compared, for instance, with nerve-force. In fact, the experiments of Helmholz have proved conclusively that such a comparison contradicts the truth. What is the peculiar sign of the vital forces and of vital unity, or the definite expression of their simultaneous action in one organism, is, precisely, organization. But electricity has no causal relation with organization proper. That is the work of some higher activity. That power in action, whatever it be, takes to itself all the forces of Nature, but it links them, coördinates them, and, fixing them into special conditions, compels their service to the purposes of life. Gravitation, heat, light, electricity, all these forces are maintained within living beings—only they are there disguised under a new phenomenal unity, just as the oxygen, hydrogen, carbon, nitrogen, and phosphorus, that make up a nerve-cell, vanish in it into a new unity of substance, without ceasing to exist in it as distinct chemical elements. The inorganic powers of Nature are as essential to life as lines and colors are in the composition of the painter's picture. What would the picture be without the painter's soul and labor? The picture is his peculiar work: the physico-chemical forces are the lines and colors of that homogeneous and harmonious composition, which is life. In it they would want meaning or power, if they did not in it, by the operation of a mysterious artist, undergo a transformation which raises them to a dignity not theirs before, and assigns their place in the supreme harmony. Thus, in the infinite solidarity of things, there is, as Leibnitz dreamed, a constant uprising of the lower toward the higher, a steady progress toward the best, a ceaseless aspiration toward a fuller and more conscious existence, an immortal growth toward perfection.—*Revue des Deux Mondes.*

PHYSICAL CHARACTERS OF THE HUMAN RACES.

By Prof. A. DE QUATREFAGES.

TRANSLATED FROM THE FRENCH BY ELIZA A. YOUMANS.

GENTLEMEN: I have already given you three lectures on the history of man. They have all been devoted to the examination of general questions, the solution of which can alone throw light on the study of the human races, and guide us in the midst of thousands of facts of detail involved in it.

These three lectures constitute the first part of the collection of facts and ideas that I have undertaken to expound to you. In these lectures, you know, I considered man in his relation to the universe and to the earth he inhabits. We found that there exists only one

species of man; that this species, much more ancient than was formerly believed, was the contemporary of the elephant and rhinoceros on the soil of France. Although spread everywhere at present, the human species, like other organic and living beings, had its special centre of creation. It must have appeared at first on a particular and circumscribed part of the globe, situated probably in the centre of Asia. Our earth then was peopled by way of migration. In the varied journeyings performed to reach all points of his domain, man has encountered thousands of conditions of existence. He has accommodated himself to them all—in other words, he has become acclimated everywhere.

There is another question we had to meet, because it was seriously put to us, but, to answer which, we had to confess the insufficiency of present knowledge: it is the question of the first origin of man. Our answer to this question was founded on science alone. I have made this declaration many times; I repeat it every time I speak before a new audience. For the most part, the problems we have considered are treated by theologians and philosophers. Neither here, nor at the museum, am I, nor do I wish to be, either a theologian or a philosopher. I am simply a man of science, and it is in the name of comparative physiology, of botanical and zoological geography, of geology and paleontology, in the name of the laws which govern man as well as animals and plants, that I have always spoken.

To-day, however, I shall not need to recur, as much as in preceding lectures, to these terms of comparison. We have to commence the study of man considered in himself; and, in the first place, to account in a general way for the modifications presented by the human type.

These modifications constitute the *characters* which serve to distinguish divers groups of men—the different human races. Before studying these races in detail, we must fix somewhat the extent and the meaning of these modifications of character.

To give order even to the brief study of the characters of the human race, it is necessary to separate them into a certain number of groups. This division is easily made, because of the multiple nature of man, which at the same time connects him with the rest of creation, and gives him a position apart.

Like all organic and living beings, man has a body. This body will furnish a first class of characters—the physical characters. Like animals, man is endowed with instinct and intelligence. Though infinitely more developed in him, these characters are not changed in their fundamental nature. They appear in the different human groups in phenomena, sometimes very different, as for instance the different languages. The differences of manifestation of this intelligence will constitute the second class of characters—the intellectual characters.

Finally, it is established that man has two grand faculties, of which we find not even a trace among animals. He alone has the moral sen-

timent of good and of evil; he alone believes in a future existence succeeding this actual life; he alone believes in beings superior to himself, that he has never seen, and that are capable of influencing his life for good or evil.

In other words, man alone is endowed with morality and religion. These two faculties are revealed by his acts, by his institutions, by facts that differ from one group to another, from one race to another. From these is drawn a third class of characters—*that of moral and religious characters.*

Let us attend to-day to the physical characters, to those furnished by the body.

In man, as in animals, the body is made up of *organs.* We can not only study the exterior of the body, but we can also penetrate the interior and discover its anatomy. Indeed, this is the only means of finding out its most important organs. In this study we can stop with the form, the arrangement, or we can go further, and seek to understand the actions of the parts, the *functions* they perform. We thus pass from anatomy to *physiology.* But these functions may be disturbed by many maladies that cannot be neglected, and which are the province of *pathology.*

In our present study, we must not neglect any of these orders of facts. You see how we are led to draw, from the body alone, four categories of characters, namely: 1. Exterior characters; 2. Anatomic characters; 3. Physiological characters; 4. Pathological characters.

PHYSICAL CHARACTERS.

I. Exterior Characters.—When we see a man or an animal, the first thing that strikes us is its size. Our domestic species are made of great and small races, and it is the same with man.

The extreme dimensions of the human form, whether great or small, have been very much exaggerated. Everywhere there has been a belief in the existence of races of dwarfs and races of giants. For instance, the Greeks believed in the existence of a people, called by them pigmies, whose country they placed sometimes in one direction, sometimes in another, but always beyond the limits of the world they truly knew. These were little men about fourteen inches in height, who, it was believed, were obliged to pluck down the corn with strokes of the axe, and who passed a part of their time defending themselves against the cranes. In the last century this fable of the pigmies was, so to speak, renewed and applied to the kymos, who were said to inhabit Madagascar. It is needless to add that, since we have seen them more closely, pigmies and kymos have disappeared.

The fables relative to giants are the contrary of the preceding. Among these fables there are some modern ones, for a time believed to be founded on real observation. The first voyagers who doubled

Cape Horn found there the Patagonians, whose dimensions they singularly exaggerated. Pigafetta, the companion of Magellan in the first voyage round the world (1520), pretended that he and his companions scarcely reached to the height of their waists. One of his successors, Jofre Loaysa, with still greater extravagance, declared that the heads of the Christians reached only to the upper part of their thighs. This was, you see, to attribute to these people a height of 13 to 16 feet.

Time and science have done justice to these fables and exaggerations. Let us see what are in reality the extremes presented by the human stature.

It is plain that in this research we must leave out exceptional individuals, of which we see a certain number in the fairs and museums, or anywhere, for money. It is a question neither of General Tom Thumb, whom you have perhaps met sometimes in the Champs Elysées, nor of the French or Chinese giants, recently exhibited in Paris. I will only remark, in passing, that these individual exceptions appear among all nations, although more rarely, perhaps, in the midst of savage populations.

The smallest known race is that of the Bushman, which inhabits the southern part of Africa; the greatest is the Patagonian, of which we just named the country. An English traveller, Barrow, measured all the inhabitants of a tribe of the first; a French traveller, Alcide d'Orbigny, took the exact measure of a great number of individuals belonging to the second of these two extreme races.

It results from these measurements that the mean height of the Bushman is 4 feet 3½ inches, and that of the Patagonian 5 feet 8 inches. The mean difference between the greatest and the smallest human race is then 16½ inches.

The smallest Bushman measured by Barrow was a woman who was only 3 feet 10½ inches. The largest Patagonian measured by D'Orbigny attained 6 feet 3 inches. The greatest difference existing, then, between normal human individuals is 2 feet 8½ inches. The ratio between the extremes of height just named is nearly as 1 to 0.6. These figures signify much and lead to important consequences.

First, the difference in size among our domestic animals is much greater than that above indicated. From the great dogs that promenade in our court-yards, down to certain dogs which have figured at dog-shows, the ratio is 1 to 0.3. The difference is also as great between the large brewers' horses of London and horses from Shetland, which are sometimes not larger than a Newfoundland dog. These horses and these dogs are, however, only different races of a single species. One cannot reason, then, from differences of height to sustain the multiplicity of human species.

There is another consideration not less important:

From all the data I can gather, it results that the mean stature of

men, the world over, is about 5 feet 3 inches. But this mean, like that given above, results from very numerous and very diverse heights. If in thought we place all men in one line according to their height, it is easy to see that we should obtain a series in which the difference from one to the next will not be, perhaps, the $\frac{1}{2500}$th of an inch.

But this is not all. In this graduated series, the men of the same race will be far from being placed together. There will be in this respect the strangest mixture. All the Patagonians are not nearly 6 feet 3 inches in height, nor all the Bushmen as short as 3 feet 10½ inches. Among our cuirassiers and the hundred guards of the emperor many individuals would be found with the first; the Lapps of the north of Europe and the Mincopees of the isles of Andaman in the Gulf of Bengal would mix with the second.

Now, in no other kind of animal, with numerous species and of limited growth, is there any thing parallel. The domestic races alone present something like its analogue. So that, by themselves, these considerations drawn from the height furnish excellent proof of the unity of the human species.

The study of proportions would show us like facts and conduct to similar conclusions. But I leave considerations of this kind, to pass to other characters almost as striking as those of height. I wish to speak of those drawn from the complexion, and first of all from the color of the skin. The general coloration of the body is a well-defined character; but we need not exaggerate its value.

If you observe several portraits representing individuals of the white race, you may see that their tint is sometimes as dark as that of the Guinea negro. In the portrait of Rammohun-Roy, the celebrated Bramin reformer, the fineness and regularity of his profile attest that he is of the purest Aryan blood, and his color is that of a negro just a little blanched. Again, there are Abyssinians whose features recall the fine Semitic type, and yet few negroes surpass them in blackness. So all black men are not negroes. Reciprocally, Livingstone has found in the centre of Africa negroes of the color of *café au lait.*

The color of the human race varies from white, such as is seen in Dutch and Danish women, to violet or yellow, to yellow-citron or smoke, to copper-red or brick. By appealing to your recollections, you can establish a series passing from light to dark by insensible shades such as could scarcely be reproduced upon the palette of a painter.

Recollect that some of these extremes of color are frequent among domestic animals, and are sometimes much greater. With black hens, it is not the skin alone that is colored. All the great interior membranes, the sheaths of the muscles, the aponeuroses, as well as the flesh of the wings, present an aspect very little appetizing. So it is sought to weed them out of the poultry-yard; and still in certain parts of the globe they are constantly produced and would evidently soon become

a race if left to multiply. Here, again, in the case of animals, the difference from race to race is much greater than in the case of man.

Sometimes, in the presence of variations of color like these we have described, we ask if, between the negro and the white, there do not exist anatomical differences in the skin? The minute study of this organ answers us in the negative.

The skin is composed of three layers, which together constitute a true organ having its proper functions. So it is often called the *cutaneous organ*. On the exterior is the *epidermis*, that dry and insensible layer which covers the entire body, and protects it against the action of outer agents.

Interiorly, and immediately above the greasy body, is the true skin—it is the essential and living part of the cutaneous organ; it is this which receives the blood-vessels and nerves.

Between the true skin and the epidermis is a dark layer, composed of distinct cells. It is the mucous membrane of Malpighi, so named from the anatomist who first described it. The cells that form it are a simple secretion of the true skin. It is this layer which is the seat of color. It exists in all men, but the cells that it contains are more or less colored according to race. In whites themselves, in certain parts of the body, around the nipples, in the specks of freckles, in the beauty-spots, etc., we sometimes see them as deep as in the negro.

You see that the color in different human races is, when developed, only a phenomenon of local coloration, of exactly the same nature as those we encounter in races of domestic animals. If time permitted me to enter more fully into the subject, I could make this fact much more evident, but the hour advances and I must hasten.

To the skin are attached a certain number of organs, which may be considered as adjuncts to the cutaneous organ. These are chiefly the villosities or hairs, the sebaceous glands, and the sweat-glands. Between these annexed organs there exists a certain balance which physiology easily explains. So in glabrous races, that is, races with little or no villosities on the body, the sebaceous apparatus is much more developed. This fact is very marked in the African negro, whose skin sometimes bears slight prominences, sketching a sort of arabesque by the extraordinary development of these little organs.

It is to the development of the sebaceous apparatus that the odor developed by the negro is due. This odor is so strong, so persistent, that it suffices to the identification of a negro-ship a long time after it has left the trade. But it is not negroes alone that are characterized by malodorous exhalations. It is the same with the whites themselves. You all know that a dog follows his master by the scent. Savage people, whose senses are more exercised than ours, distinguish very quickly the general odor which characterizes a race; and, in Peru, they give special names to that of the white and of the black as well as to their own.

As to the hair which may be seen on different parts of the body, a special mention is due to that of the head. All people have more or less hair on the head, and this gives also very good characters. Among these the most essential are drawn from the form presented by the transverse cut when examined under the microscope. In the yellow people, the Americans and the white allophyles, this cut is more or less circular. In the Aryans, of which we are a part, it is oval; in the negroes it takes the form of an elongated ellipse. It is evident that a circular cut indicates a cylindrical hair. Such hair is very coarse and stiff, and never curling or frizzled; an oval cut indicates a slight and regular flattening. In this form the hairs are finer, and may be made into curls or waves more or less marked. Finally, the elliptical cut can only appear when the hair is much flattened, almost like a thick ribbon. These are the finest, and these alone have the aspect of wool which characterizes the head of the negro.

Crosses between these different races sometimes produce very remarkable heads of hair. The negro crossed with the Brazilian produces the Cafuso, whose hair, forming an immense wig, is at the same time long, stiff, and kinked.

I would further enlarge upon these exterior characters, as being the ones of which we can most easily give account, but time fails me, and I pass to the second class of characters, to those which we must seek in the interior.

II. Anatomic Character.—The anatomic character may be drawn from the solid parts of the body, that is, the skeleton, from the soft parts, and even from the liquids. I shall at first confine myself particularly to those drawn from the head.

In the head itself we must distinguish the cranium from the face. The first encloses the brain, whence proceed the organs of sense, with the exception of those of touch, properly speaking. Above all, it is the seat of intelligence; on these various accounts it merits a separate examination.

The general form of the cranium, that is, the relation between the longitudinal and transverse diameter, furnishes an excellent character. When this relation is less than that of 100 to 78, the cranium is considered as elongated from front to back: it is *dolichocephalic*. When the relation varies from 100 to 78 or 80, the cranium is medium or average; we say it is *mesocephalic*. Finally, when the relation is from 100 to 80, and above, the cranium is considered short, and is said to be *brachycephalic*.

These forms sometimes characterize very large human groups. So almost all the negroes are dolichocephalic; nearly all the yellow people, and most of the Americans, are brachycephalic or mesocephalic. Among the whites, and even sometimes in two populations belonging to the same branch of the white race, we find the two ex-

tremes. The Germans of the north are dolichocephalic, the Germans of the south brachycephalic.

While recognizing the importance of the characters drawn from these general forms, we must guard ourselves against exaggerating their import or giving them a wrong signification. Some authors, belonging to the dolichocephalic races, have pretended that the elongation of the head behind is a sign of intellectual superiority. The fact I have just stated suffices to refute this conclusion, and nothing justifies it. The Germans of the south are noways inferior to their countrymen of the north. In the Academy of Sciences in Paris, the brachycephalic crania, or at most the mesocephalic, are in very great majority; and still, what association of men is superior, in an intellectual point of view, to this philosophical body?

Analogous indications have been drawn from the greater or less capacity of the cranium. It has been supposed that this exactly corresponded in measure to the volume of the brain, and this volume has been regarded as a sort of measure of intellectual power.

That there is some truth at the bottom of the idea that a brain sufficiently developed is necessary to give the power to fulfil its functions, is what all the world admits. But that intellectual power is measured by the quantity of cerebral matter entering into the composition of the organ is in contradiction to the observations and the figures of many anatomists, among others, of R. Wagner.

In considerations of this nature we do not generally take account of the stature. Now, although the head does not enlarge in the same proportion as the rest of the body, it is not the less true that its form has an influence on its dimensions and on those of the cranium.

Besides, with organized and living beings, the volume, the mass of organs, is not all. Their special energy is much more. Certainly you all know small persons, of slender aspect, who are more active and strong than some of their comrades who are larger and more muscular. Well, how is it that what is true of flesh, of muscle, is not also true of brain?

After the cranium we come to the face. But I will only speak of a single order of characters drawn from the jaws and teeth.

Observe a negro, and a European. Look at the jaws and teeth of the first. You see them project in front. In the second, on the contrary, teeth and jaws are equally vertical. The first of these is called *prognathism*, and the peoples or individuals who present them are said to be prognathous; the second takes the name of orthognathism and characterizes the orthognathous races or individuals.

Prognathism has long been considered as characterizing the negro races. Since, we have found it in people who could not be affiliated with the negro; and, finally, looking closely into the matter, we have found it in the heart of white populations. At Paris, even, it is frequent enough, particularly among women. This is a fact of which

you can convince yourself, as I have often done during my rides in the omnibus.

Judging by the crania that we possess, prognathism is characteristic of a population incontestably European which lives at the south of the Baltic, the Esthonians. This people is, furthermore, the remains of the most ancient race of Western Europe. It is this race, without doubt, which, mixing its blood with new-comers, has left in the midst of our great cities those indications of a prognathous race to which I have just referred.

After studying the cranium and face separately, we must examine the head in its *ensemble*. From this also we draw important characters. I will only mention one, which has a certain real value, but the signification of which some have exaggerated and falsified.

Camper, an anatomist of Holland, studied comparatively the Greek and Roman medallions and statues, and struck with the air of majesty, presented by the Greeks, gave for a reason that the *facial angle* was greater than in the Romans. This angle is formed by two lines which meet at the extremity of the front teeth, and of which one passes by the middle of the orifice of the ear, while the second is tangent to the forehead.

Pushing these researches much further, Camper believed that he discovered a regular decrease of the facial angle in the human race, so that he could characterize a race by its facial angle. Going further, and applying it to animals, he placed in a descending scale, man, monkeys, carnivora, birds, all characterized by smaller and smaller angles. Whence, to conclude that the facial angle measures, so to say, the intelligence, is but a step, which was taken without hesitation.

As this conclusion gives great interest to the measurement of the facial angle, many processes and many instruments have been proposed to obtain it with all possible exactitude. The *goniometre*, invented by my assistant M. Docteur Jacquart, attained this end better than any other.

Jacquart did not stop with making this instrument. He used it; and, in a beautiful work, he shows among other things that the right angle exists in the white race, contrary to what Camper believed; that we may observe it, without doubt, in intelligent persons, but who are, however, not sensibly superior to others whose angle is much less considerable. The facial angle cannot, then, be considered as measuring the intelligence, the reach of the mind.

M. Jacquart shows, besides, that, in the single population of Paris, the angular differences of which we are speaking are much more considerable than those that Camper regarded as characterizing races. He shows that here, again, there is from race to race that entanglement of characters which I have so many times pointed out. Yet, here as elsewhere, the average furnishes good characters to determine human groups.

Again, the skeleton presents important characters. We ought, at least, to examine the breast, the pelvis, the bones of the limbs, etc.; but we must leave this subject, to say a word on the soft parts.

Regarded in the two extremes of humanity, the white European and the negro, the nervous system presents a fact which it is important to point out. With the first, the nervous centres—the brain and spinal cord—are relatively more voluminous. In the second, on the contrary, it is the expansions from the centres—the nerves—which are more voluminous.

The circulatory apparatus presents a balance somewhat analogous. With the white, the arterial apparatus, which carries the blood to the organs, is relatively more developed than the venous apparatus that draws the blood toward the heart.

The blood of the negro, studied in his native country, is more viscous and darker colored than that of the white. That of the creole negro of New Orleans is, on the contrary, paler and more aqueous, and recalls the blood of the anæmic. So, a simple change of habitat sometimes modifies a human race in this most profound character—in this liquid pabulum destined to penetrate and nourish all parts of the body.

III. Physiological Characters.—I shall dwell briefly on the physiological characters, and only point out two general facts, of which you will easily see the importance:

As regards all the great periods of life and all the great functions, there is an almost complete identity among all men, to whatever race they belong.

When this resemblance is not apparent, the cause is not in the nature of the races, but in the influence of conditions of existence. This is well proved by the fact that races the most widely separated resemble each other completely when they are exposed to identical conditions through a change of habitat. So, the precocity of the negro has been cited as distinguishing this race from European nations; but, when white people live for generations in hot countries, they take on the same peculiarity. The negress and the English creole of the isles of the Gulf of Mexico are just alike in precocity.

On the contrary, the study of secondary functions shows that they vary from one group to another, and sometimes very widely. But, then, also, we see that the environment, the manners, the habits, etc., are the cause of these variations; and, again, we see races the most unlike come to resemble each other so much as to be confounded together. There are hunters of English and French descent who have the senses of sight and hearing as quick and sharp as the red-skins.

In concluding, the study of physiological characters strongly attests the fundamental unity of the human race, by throwing light on the marvellous flexibility of our organism.

IV. Pathological Characters.—The study of diseases presents entirely similar facts, and conducts to the same conclusions.

All the human races are accessible to the same diseases. If any circumstances—isolation, for instance—have preserved some one of them from affections common to the others, a simple coming together suffices for the propagation of the disease. The eruptive maladies seem to have been implanted in America by the Europeans; but, once implanted among the indigenous races, they have raged with a violence that we know not—a violence which is accounted for by the kind of life led by these people.

Yet immunities, at least relative, have been proved. For instance, the negro race is much less sensible to the emanations of marshes, to the miasms from stagnant waters, than the white race. In return, it is much more easily affected by phthisis.

Other more complete immunities have been observed, and some have even wished, in consequence, to justify the admission of a distinct human species. But these immunities, even the best marked, disappear with time, and still more under the influence of conditions of existence. I will give you a curious example:

Elephantiasis is a hideous malady, peculiar to certain warm countries, which swells and deforms, sometimes in the strangest way, the parts of the body it attacks. In one of the Antilles, in Barbadoes, this disease was seen from the first among the negroes, but had constantly spared the whites, till 1704. That year a white person was seized, and since then the malady has extended in this race; but it never attacks any but creoles. Up to the present time, Europeans, who settle in this isle, enjoy the ancient immunity. You see it is only a question of complete acclimation.

Gentlemen, I believe I have sketched, in this one lecture, a body of facts and ideas which, at the museum, occupied at least ten lectures, each as long as this to-day. So, you see how many things I have been compelled to omit. Incomplete as I have been compelled to make this presentation, it is sufficient, I think, to establish clearly some general facts, and prepares the way for an important conclusion.

You have seen that, considering man from the point of view of his height and color, we may form a graduated series which passes from one extreme to the other by insensible shades. You have seen further that, in this series, groups the most distinct by other characters—the most separated by their habitat—are found intermixed.

Permit me to add that we should get the same result, whatever the exterior or anatomical character upon which we establish our series.

The study of functions, whether performed in a normal manner, in a state of health, or under the perturbing influence of disease, shows us identical fundamental facts revealing the unity of human nature.

Even apparent exceptions come under the general facts when we

take account of the influence of the environment which, as you have seen, effaces some of the most marked differences.

In this examination of the physical man, every thing leads to the conclusion which we had already reached in our earlier lectures; and we can repeat with redoubled certainty: the differences among human groups are characters of race, and not of species; there exists only one human species; and, consequently, all men are brothers—all ought to be treated as such, whatever the origin, the blood, the color, the race.

Gentlemen, the lectures I have given here require a special preparation, and are not always easy to prepare; but I shall not regret either my time or my pains, if I am able, in the name of science, and that alone, to render a little more clear and precise for you this great and sacred notion of the brotherhood of man.

ON THE EQUALITY OF THE SEXES.[1]

SIR: In the foregoing letter I have examined the theory of the connection between equality and justice, with the view of showing that the only real connection between the two ideas is to be found in the fact that, as justice implies general rules, it also implies an impartial application of those rules to all the particular cases to which they may apply. I also showed that when equality is spoken of as being just or unjust in any more general sense than this, the expression can mean nothing else than that it is or is not generally expedient. The doctrine upon this subject which I deny, and which I am disposed to think Mr. Mill affirms—though, if he does, it is with somewhat less than his usual transparent vigor and decision—is that equality is in itself always expedient, or, to say the very least, presumably expedient, and that in every case of inequality the burden of proof lies on those who justify its maintenance.

If I had time to do so, I might give in proof or illustration of this the whole of his essay on the "Subjection of Women," a work from which I dissent from the first sentence to the last, but which I will consider on the present occasion only with reference to the particular topic of equality, and as the strongest distinct illustration known to me of what is perhaps one of the strongest, and what appears to me to be by far the most ignoble, contemptible, and mischievous of all the popular feelings of the age.

The object of Mr. Mill's essay is to explain the grounds of the opinion that "the principle which regulates the existing social relations between the two sexes, the legal subordination of one sex to the other, is wrong in itself, and now one of the chief hindrances to human

[1] From the letters of "F.," in the *Pall Mall Budget*.

improvement; and that it ought to be replaced by a principle of perfect equality, admitting no power or privilege on the one side, nor disability on the other."

Mr. Mill is fully aware of the difficulty of his task. He admits that he is arguing against "an almost universal opinion," but he urges that it and the practice founded on it is a relic of a by-gone state of things. "We now live—that is to say, one or two of the most advanced nations of the world now live—in a state in which the law of the strongest seems to be entirely abandoned as the regulating principle of the world's affairs. Nobody professes it, and, as regards most of the relations between human beings, nobody is permitted to practise it. . . . This being the ostensible state of things, people flatter themselves that the rule of mere force is ended." Still they do not know how hard it dies, and in particular they are unaware of the fact that it still regulates the relations between men and women. It is true that the actually existing generation of women do not dislike their position. The consciousness of this haunts Mr. Mill throughout the whole of his argument, and embarrasses him at every turn. He is driven to account for it by such assertions as that "each individual of the subject class is in a chronic state of bribery and intimidation combined," by reference to the affection which slaves in classical times felt for their masters in many cases, and by other suggestions of the same sort. His great argument against the present state of things is that it is opposed to what he calls "the modern conviction, the fruit of a thousand years of experience"—

> "That things in which the individual is the person directly interested never go right but as they are left to his own discretion, and that any regulation of them by authority except to protect the rights of others is sure to be mischievous. . . . The peculiar character of the modern world . . . is that human beings are no longer born to their place in life and chained down by an inexorable bond to the place they are born to, but are free to employ their faculties and such favorable chances as offer, to achieve the lot which may appear to them most desirable. Human society of old was constituted on a very different principle. All were born to a fixed social position, and were mostly kept in it by law or interdicted from any means by which they could emerge from it. . . . In consonance with this doctrine it is felt to be an overstepping of the proper bounds of authority to fix beforehand on some general presumption that certain persons are not fit to do certain things. It is now thoroughly known and admitted that if some such presumptions exist no such presumption is infallible. . . . Hence we ought not . . . to ordain that to be born a girl instead of a boy shall decide the person's position all through life."

The result is that "the social subordination of women thus stands out as an isolated fact in modern social institutions." It is in "radical opposition" to "the progressive movement, which is the boast of the modern world." This fact creates a "*prima-facie* presumption" against it, "far outweighing any which custom and usage could in such circumstances create" in its favor.

take account of the influence of the environment which, as you have seen, effaces some of the most marked differences.

In this examination of the physical man, every thing leads to the conclusion which we had already reached in our earlier lectures; and we can repeat with redoubled certainty: the differences among human groups are characters of race, and not of species; there exists only one human species; and, consequently, all men are brothers—all ought to be treated as such, whatever the origin, the blood, the color, the race.

Gentlemen, the lectures I have given here require a special preparation, and are not always easy to prepare; but I shall not regret either my time or my pains, if I am able, in the name of science, and that alone, to render a little more clear and precise for you this great and sacred notion of the brotherhood of man.

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I will not follow Mr. Mill through the whole of his argument, much of which consists of matter not relevant to my present purpose, and not agreeable to discuss, though many of his assertions provoke reply. There is something—I hardly know what to call it, indecent is too strong a word, but I may say unpleasant in the direction of indecorum—in prolonged and minute discussions about the relations between men and women, and the characteristics of women as such. I will therefore pass over what Mr. Mill says on this subject with a mere general expression of dissent from nearly every word he says. The following extracts show the nature of that part of his theory which bears on the question of equality:

"The equality of married persons before the law . . . is the only means of rendering the daily life of mankind in any high sense a school of moral cultivation. Though the truth may not be felt or generally acknowledged for generations to come, the only school of genuine moral sentiment is society between equals. The moral education of mankind has hitherto emanated chiefly from the law of force, and is adapted almost solely to the relations which force creates. In the less advanced states of society, people hardly recognize any relation with their equals. To be an equal is to be an enemy. Society, from its highest place to its lowest, is one long chain, or rather ladder, where every individual is either above or below his nearest neighbor, and wherever he does not command he must obey. Existing moralities, accordingly, are mainly fitted to a relation of command and obedience. Yet command and obedience are but unfortunate necessities of human life; society in equality is its normal state. Already in modern life, and more and more as it progressively improves, command and obedience become exceptional facts in life, equal association its general rule. . . . We have had the morality of submission and the morality of chivalry and generosity; the time is now come for the morality of justice."

In another part of the book this doctrine is stated more fully in a passage of which it will be enough for my purpose to quote a very few lines:

"There are many persons for whom it is not enough that the inequality" (between the sexes) "has no just or legitimate defence; they require to be told what express advantage would be obtained by abolishing it. To which let me first answer, the advantage of having all the most universal and pervading of all human relations regulated by justice instead of injustice. The vast amount of this gain to human nature it is hardly possible by any explanation or illustration to place in a stronger light than it is placed in by the bare statement to any one who attaches a moral meaning to words."

These passages show what Mr. Mill's doctrine of equality is, and how it forms the very root, the essence, so to speak, of his theory about the subjection of women. I consider it unsound in every respect. I think that it rests upon an unsound view of history, an unsound view of morals, and a grotesquely distorted view of facts, and I believe that its practical application would be as injurious as its theory is false.

The theory may be shortly restated in the following propositions,

which I think are implied in or may be collected from the extracts given above. They are as follows:

1. Justice requires that all people should live in society as equals.

2. History shows that human progress has been a progress from a "law of force" to a condition in which command and obedience become exceptional.

3. The "law of the strongest" having in this and one or two other countries been "entirely abandoned" in all other relations of life, it may be presumed not to apply to the relation between the sexes.

4. The notorious facts as to the nature of that relation show that in this particular case the presumption is, in fact, well founded.

I dissent from each of these propositions. In the present letter I shall examine the first and the fourth, which may be regarded as an illustration of the first. On a subsequent occasion I shall consider the second and third. First, as to the proposition that justice requires that all people should live in society as equals. I have already shown that this is equivalent to the proposition that it is expedient that all people should live in society as equals. Can this be proved? for it is certainly not a self-evident proposition.

I think that if the rights and duties which laws create are to be generally advantageous, they ought to be adapted to the situation of the persons who enjoy or are subject to them. They ought to recognize both substantial equality and substantial inequality, and they should from time to time be so moulded and altered as always to represent fairly well the existing state of society. Government, in a word, ought to fit society as a man's clothes fit him. To establish by law rights and duties which assume that people are equal when they are not is like trying to make clumsy feet look handsome by the help of tight boots. No doubt it may be necessary to legislate in such a manner as to correct the vices of society, or to protect it against special dangers or diseases to which it is liable. Law in this case is analogous to surgery, and the rights and duties imposed by it might be compared to the irons which are sometimes contrived for the purpose of supporting a weak limb or keeping it in some particular position. As a rule, however, it is otherwise. Rights and duties should be so moulded as to clothe, protect, and sustain society in the position which it naturally assumes. The proposition, therefore, that justice demands that people should live in society as equals may be translated thus: "It is inexpedient that any law should recognize any inequality between human beings."

This appears to me to involve the assertion, "There are no inequalities between human beings of sufficient importance to influence the rights and duties which it is expedient to confer upon them." This proposition I altogether deny. I say that there are many such differences, some of which are more durable and more widely extended than others, and of which some are so marked and so important that, un-

less human nature is radically changed, we cannot even imagine their removal; and of these the differences of age and sex are the most important.

The difference of age is so distinct a case of inequality that even Mr. Mill does not object to its recognition. He admits, as every one must, that perhaps a third or more of the average term of human life —and that the portion of it in which the strongest, the most durable, and beyond all comparison the most important impressions are made on human beings, the period in which character is formed—must be passed by every one in a state of submission, dependence, and obedience to orders the objects of which are usually most imperfectly understood by the persons who receive them. Indeed, as I have pointed out in previous letters, Mr. Mill is disposed rather to exaggerate than to underrate the influence of education and the powers of educators. Is not this a clear case of inequality of the strongest kind, and does it not at all events afford a most instructive precedent in favor of the recognition by law of a marked natural distinction? If children were regarded by law as the equals of adults, the result would be something infinitely worse than barbarism. It would involve a degree of cruelty to the young which can hardly be realized even in imagination. The proceeding, in short, would be so utterly monstrous and irrational that I suppose it never entered into the head of the wildest zealot for equality to propose it. Upon the practical question all are agreed; but consider the consequences which it involves. It involves the consequence that, so far from being "unfortunate necessities," command and obedience stand at the very entrance to life, and preside over the most important part of it. It involves the consequence that the exertion of power and constraint is so important and so indispensable in the greatest of all matters that it is a less evil to invest with it every head of a family indiscriminately, however unfit he may be to exercise it, than to fail to provide for its exercise. It involves the consequence that, by mere lapse of time and by following the promptings of passion, men acquire over others a position of superiority and of inequality which all nations and ages, the most cultivated as well as the rudest, have done their best to surround with every association of awe and reverence. The title of Father is the one which the best part of the human race have given to God, as being the least inadequate and inappropriate means of indicating the union of love, reverence, and submission. Whoever first gave the command or uttered the maxim, "Honor thy father and thy mother, that thy days may be long in the land," had a far better conception of the essential conditions of permanent national existence and prosperity than the author of the motto "Liberty, Equality, and Fraternity."

Now, if society and government ought to recognize the inequality of age as the foundation of an inequality of rights of this importance, it appears to me at least equally clear that they ought to recognize the

inequality of sex for the same purpose, if it is a real inequality. Is it one? There are some propositions which it is difficult to prove, because they are so plain, and this is one of them. The physical differences between the two sexes affect every part of the human body, from the hair of the head to the sole of the feet, from the size and density of the bones to the texture of the brain and the character of the nervous system. Ingenious people may argue about any thing, and Mr. Mill does say a great number of things about women which, as I have already observed, I will not discuss; but all the talk in the world will never shake the proposition that men are stronger than women in every shape. They have greater muscular and nervous force, greater intellectual force, greater vigor of character. This general truth, which has been observed under all sorts of circumstances and in every age and country, has also in every age and country led to a division of labor between men and women, the general outline of which is as familiar and as universal as the general outline of the differences between them. These are the facts, and the question is, whether the law and public opinion ought to recognize this difference. How it ought to recognize it, what difference it ought to make between men and women as such, is quite another question. The first point to consider is, whether it ought to treat them as equals, although, as I have shown, they are not equals, because men are the stronger. I will take one or two illustrations. Men, no one denies, may, and in some cases ought to, be liable to compulsory military service. No one, I suppose, would hesitate to admit that, if we were engaged in a great war, it might become necessary, or that if necessary it would be right, to have a conscription both for the land and for the sea service. Ought men and women to be subject to it indiscriminately? If any one says that they ought, I have no more to say, except that he has got into the region at which argument is useless. But if it is admitted that this ought not to be done, an inequality of treatment founded on a radical inequality between the two sexes is admitted, and, if this admission is once made, where are you to draw the line? Turn from the case of liability to military service to that of education, which in Germany is rightly regarded as the other great branch of state activity, and the same question presents itself in another shape. Are boys and girls to be educated indiscriminately, and to be instructed in the same things? Are boys to learn to sew, to keep house, and to cook, as girls unquestionably ought to be, and are girls to play at cricket, to row, and be drilled like boys? I cannot argue with a person who says Yes. A person who says No admits an inequality between the sexes on which education must be founded, and which it must therefore perpetuate and perhaps increase.

Follow the matter a step further to the vital point of the whole question—marriage. Marriage is one of the subjects with which it is absolutely necessary both for law and morals to deal in some way

or other. All that I need consider in reference to the present purpose is the question whether the laws and moral rules which relate to it should regard it as a contract between equals, or as a contract between a stronger and a weaker person involving subordination for certain purposes on the part of the weaker to the stronger. I say that a law which proceeded on the former and not on the latter of these views would be founded on a totally false assumption, and would involve cruel injustice in the sense of extreme general inexpediency, especially to women. If the parties to a contract of marriage are treated as equals, it is impossible to avoid the inference that marriage, like other partnerships, may be dissolved at pleasure. The advocates of women's rights are exceedingly shy of stating this plainly. Mr. Mill says nothing about it in his book on the "Subjection of Women," though in one place he comes very near to saying so, but it is as clear an inference from his principles as any thing can possibly be, nor has he ever disavowed it. If this were the law, it would make women the slaves of their husbands. A woman loses the qualities which make her attractive to men much earlier than men lose those which make them attractive to women. The tie between a woman and young children is generally far closer than the tie between them and their father. A woman who is no longer young, and who is the mother of children, would thus be absolutely in her husband's power, in nine cases out of ten, if he might put an end to the marriage when he pleased. This is one inequality in the position of the parties which must be recognized and provided for beforehand if the contract is to be for their common good. A second inequality is this: When a man marries, it is generally because he feels himself established in life. He incurs, no doubt, a good deal of expense, but he does not in any degree impair his means of earning a living. When a woman marries, she practically renounces in all but the rarest cases the possibility of undertaking any profession but one, and the possibility of carrying on that one profession in the society of any man but one. Here is a second inequality. It would be easy to mention others of the deepest importance, but these are enough to show that to treat a contract of marriage as a contract between persons who are upon an equality in regard of strength and power to protect their interest is to treat it as being what it notoriously is not.

Again, the contract is one which involves subordination and obedience on the part of the weaker party to the stronger. The proof of this is, to my mind, as clear as that of a proposition in Euclid, and it is this:

1. Marriage is a contract, one of the principal ones of which is the government of a family.

2. This government must be vested either by law or by contract in the hands of one of the two married persons.

3. If the arrangement is made by contract, the remedy for breach

of it must either be by law or by a dissolution of the partnership at the will of the contracting parties.

4. Law could give no remedy in such a case. Therefore the only remedy for breach of the contract would be dissolution of the marriage.

5. Therefore, if marriage is to be permanent, the government of the family must be put by law and by moral rules in the hands of the husband, for no one proposes to give it to the wife.

Mr. Mill is totally unable to meet this argument, and apparently embraces the alternative that marriage ought to be dissoluble at the pleasure of the parties. After much argument as to contracts which appear to be visionary, his words are these: "Things never come to an issue of downright power on one side and obedience on the other except where the connection has been altogether a mistake, and it would be a blessing to both parties to be relieved from it."

This appears to me to show a complete misapprehension of the nature of family government, and of the sort of cases in which the question of obedience and authority can arise between husband and wife. No one contends that a man ought to have power to order his wife about like a slave, and beat her if she disobeys him. Such conduct in the eye of the law would be cruelty, and ground for a separation. The question of obedience arises in quite another way. It may, and no doubt often does, arise between the very best and most affectionate married people, and it need no more interfere with their mutual affection than the absolute power of the captain of a ship need interfere with perfect friendship and confidence between himself and his first-lieutenant. Take the following set of questions: "Shall we live on this scale or that? Shall we associate with such and such persons? Shall I, the husband, embark in such an undertaking, and shall we change our place of residence in order that I may do so? Shall we send our son to college? Shall we send our daughters to school or have a governess? For what profession shall we train our sons?" On these and a thousand other such questions the wisest and the most affectionate people might arrive at opposite conclusions. What is to be done in such a case? for something must be done. I say the wife ought to give way. She ought to obey her husband, and carry out the view at which he deliberately arrives, just as, when the captain gives the word to cut away the masts, the lieutenant carries out his orders at once, though he may be a better seaman and may disapprove them. I also say that, to regard this as a humiliation, as a wrong, or as an evil in itself, is a mark not of spirit and courage, but of a base, unworthy, mutinous disposition—a disposition utterly subversive of all that is most worth having in life. The tacit assumption involved in it is that it is a degradation ever to give up one's own will to the will of another, and to me this appears the root of all evil, the negation of that which renders any combined efforts possible. No case can be specified in

which people unite for a common object, from making a pair of shoes up to governing an empire, in which the power to decide does not rest somewhere; and what is this but command and obedience? Of course the person who for the time being is in command is of all fools the greatest if he deprives himself of the advantage of advice, if he is obstinate in his own opinion, if he does not hear as well as determine; but it is also practically certain that his inclination to hear will be proportioned to the degree of importance which he has been led to attach to the function of determining.

To sum the matter up, it appears to me that all the laws and moral rules by which the relation between the sexes is regulated should proceed upon the principle that their object is to provide for the common good of two great divisions of mankind who are connected together by the closest and most durable of all bonds, and who can no more have really conflicting interests than the different members of the same body, but who are not and never can be equals in any of the different forms of strength.

This problem law and morals have solved by monogamy, indissoluble marriage on the footing of the obedience of the wife to the husband, and a division of labor with corresponding differences in the matters of conduct, manners, and dress. Substantially this solution appears to me to be right and true; but I freely admit that in many particulars the stronger party has in this, as in other cases, abused his strength, and made rules for his supposed advantage, which, in fact, are greatly to the injury of both parties. It is needless to say any thing in detail of the stupid coarseness of the laws about the effects of marriage on property—laws which might easily be replaced by a general statutory marriage settlement analogous to those which every prudent person makes who has any thing to settle. As to acts of violence against women, by all means make the law on this head as severe as it can be made without defeating itself.

As to throwing open to women the one or two employments from which they are at present excluded, it is rather a matter of sentiment than of practical importance. I need not revive in this place a trite discussion. My object at present is simply to establish the general proposition that men and women are not equals, and that the laws which affect their relations ought to recognize that fact.

In my next letter I shall examine the opinion that laws which recognize any sort of inequality between human beings are mere vestiges of the past, against which as such there lies the strongest of all presumptions.—I am, sir, your obedient servant, "F."

INSTINCT IN YOUNG BIRDS.

By D. A. SPALDING.

WITH regard to instinct we have yet to ascertain the facts. Do the animals exhibit untaught skill and innate knowledge? May not the supposed examples of instinct be after all but the results of rapid learning and imitation? The controversy on this subject has been chiefly concerning the perceptions of distance and direction by the eye and the ear. Against the instinctive character of these perceptions it is argued that, as distance means movement, locomotion, the very essence of the idea is such as cannot be taken in by the eye or ear; that what the varying sensations of sight and hearing correspond to, must be got at by moving over the ground by experience. The results, however, of experiments on chickens were wholly in favor of the instinctive nature of these perceptions. Chickens kept in a state of blindness by various devices, from one to three days, when placed in the light under a set of carefully-prepared conditions, gave conclusive evidence against the theory that the perceptions of distance and direction by the eye are the result of associations formed in the experience of each individual life. Often, at the end of two minutes, they followed with their eyes the movements of crawling insects, turning their heads with all the precision of an old fowl. In from two to fifteen minutes they pecked at some object, showing, not merely an instinctive perception of distance, but an original ability to measure distance with something like infallible accuracy. If beyond the reach of their necks, they walked or ran up to the object of their pursuit, and may be said to have invariably struck it, never missing by more than a hair's-breadth; this, too, when the specks at which they struck were no bigger than the smallest visible dot of an *i*. To seize between the points of the mandible at the very instant of striking seemed a more difficult operation. Though at times they seized and swallowed an insect at the first attempt, more frequently they struck five or six times, lifting once or twice before they succeeded in swallowing their first food. To take, by way of illustration, the observations on a single case a little in detail: A chicken, at the end of six minutes, after having its eyes unveiled, followed with its head the movements of a fly twelve inches distant; at ten minutes, the fly, coming within reach of its neck, was seized and swallowed at the first stroke; at the end of twenty minutes it had not attempted to walk a step. It was then placed on rough ground within sight and call of a hen, with chickens of its own age. After standing chirping for about a minute, it went straight toward the hen, displaying as keen a perception of the qualities of the outer world as it was ever likely to possess in after-life. It never required to knock its head against a stone to discover that there

was "no road that way." It leaped over the smaller obstacles that lay in its path, and ran round the larger, reaching the mother in as nearly a straight line as the nature of the ground would permit. Thus it would seem that, prior to experience, the eye—at least the eye of the chicken—perceives the primary qualities of the external world, all arguments of the purely analytical school of psychology to the contrary, notwithstanding.

Not less decisive were experiments on hearing. Chickens hatched and kept in the dark for a day or two, on being placed in the light nine or ten feet from a box in which a brooding hen was concealed, after standing chirping for a minute or two, uniformly set off straight to the box in answer to the call of the hen which they had never seen and never before heard. This they did struggling through grass and over rough ground, when not able to stand steadily on their legs. Again, chickens that from the first had been denied the use of their eyes, by having hoods drawn over their heads while yet in the shell, were, while thus blind, made the subject of experiment. These, when left to themselves, seldom made a forward step, their movements were round and round and backward; but, when placed within five or six feet of the hen-mother, they, in answer to her call, became much more lively, began to make little forward journeys, and soon followed her by sound alone, though of course blindly. Another experiment consisted in rendering chickens deaf for a time by sealing their ears with several folds of gum-paper before they had escaped from the shell. These, on having their ears opened when two or three days old, and being placed within call of the mother, concealed in a box or on the other side of a door, after turning round a few times ran straight to the spot whence came the first sound they had ever heard. Clearly, of these chickens it cannot be said that sounds were to them at first but meaningless sensations.

One or two observations favorable to the opinion that animals have an instinctive knowledge of their enemies may be taken for what they are worth. When twelve days old, one of my little *protégés*, running about beside me, gave the peculiar chirp whereby they announce the approach of danger. On looking up, a sparrow-hawk was seen hovering at a great height overhead. Again, a young hawk was made to fly over a hen with her first brood of chickens, then about a week old. In the twinkling of an eye, most of the chickens were hid among grass and bushes. And scarcely had the hawk touched the ground, about twelve yards from where the hen had been sitting, when she fell upon it, and would soon have killed it outright. A young turkey gave even more striking evidence. When ten days old it heard the voice of a hawk for the first time, and just beside it. Like an arrow from the bow it darted off in the opposite direction, and, crouched in a corner, remained for ten minutes motionless and dumb with fear. Out of a vast number of experiments with chickens and bees, though the

results were not uniform, yet, in the great majority of instances, the chickens gave evidence of instinctive fear of these sting-bearing insects.

But to return to examples of instinctive skill and knowledge, concerning which I think no doubt can remain, a very useful instinct may be observed in the early attention that chickens pay to their toilet. As soon as they can hold up their heads, when only from four to five hours old, they attempt dressing at their wings, that, too, when they have been denied the use of their eyes. Another incontestable case of instinct may be seen in the art of scraping in search of food. Without any opportunities of imitation, chickens begin to scrape when from two to six days old. Most frequently the circumstances are suggestive; at other times, however, the first attempt, which generally consists of a sort of nervous dance, was made on a smooth table. The unacquired dexterity shown in the capture of insects is very remarkable. A duckling one day old, on being placed in the open air for the first time, almost immediately snapped at, and caught, a fly on the wing. Still more interesting is the instructive art of catching flies peculiar to the turkey. When not a day and a half old I observed a young turkey, which I had adopted while yet in the shell, pointing its beak slowly and deliberately at flies and other small insects without actually pecking at them. In doing this its head could be seen to shake like a hand that is attempted to be held steady by a visible effort. This I recorded when I did not understand its meaning. For it was not until afterward that I observed a turkey, when it sees a fly settle on any object, steals on the unwary insect with slow and measured step, and, when sufficiently near, advances its head very slowly and steadily until within reach of its prey, which is then seized by a sudden dart. In still further confirmation of the opinion that such wonderful examples of dexterity and cunning are instinctive and not acquired, may be adduced the significant fact that the individuals of each species have little capacity to learn any thing not found in the habits of their progenitors. A chicken was made, from the first and for several months, the sole companion of a young turkey. Yet it never showed the slightest tendency to adopt the admirable art of catching flies that it saw practised before its eyes every hour of the day.

The only theory in explanation of the phenomena of instinct that has an air of science about it is, the doctrine of Inherited Association. Instinct in the present generation of animals is the product of the accumulated experiences of past generations. Great difficulty, however, is felt by many in conceiving how any thing so impalpable as fear at the sight of a bee should be transmitted from parent to offspring. It should be remembered, however, that the permanence of such associations in the history of an individual life depends on the corresponding impress given to the nervous organization. We cannot, strictly

speaking, experience any individual act of consciousness twice over; but as, by pulling the bell-cord to-day we can, in the language of ordinary discourse, produce the same sound we heard yesterday, so, while the established connections among the nerves and nerve-centres hold, we are enabled to live our experiences over again. Now, why should not those modifications of brain-matter that, enduring from hour to hour and from day to day, render acquisition possible, be, like any other physical peculiarity, transmitted from parent to offspring? That they are so transmitted is all but proved by the facts of instinct, while these, in their turn, receive their only rational explanation in this theory of Inherited Association.—*Nature.*

THE STUDY OF SOCIOLOGY.

By HERBERT SPENCER.

VIII.—*The Educational Bias.*

IT would clear up our ideas about many things, if we distinctly recognized the truth that we have two religions. Primitive humanity has but one. The humanity of the remote future will have but one. The two are opposed; and we who live midway in the course of civilization have to believe in both.

These two religions are adapted to two conflicting sets of social requirements. The one set is supreme at the beginning; the other set will be supreme at the end; and a compromise has to be maintained between them during the progress from beginning to end. On the one hand, there is the necessity of social self-preservation in face of external enemies. On the other hand, there is the necessity of coöperation among fellow-citizens, which can exist only in proportion as fair dealing of man with man creates mutual trust. Unless the one necessity is met, the society disappears by extinction, or by absorption into some conquering society. Unless the other necessity is met, there cannot be that division of labor, exchange of services, consequent industrial progress and increase of numbers, by which a society is made strong enough to survive. In adjustment to these two antagonist necessities, there grow up two antagonist codes of duty; which severally acquire supernatural sanctions. And thus we get the two coexisting religions—the religion of enmity and the religion of amity.

Of course, I do not mean that these are both called religions. Here I am not speaking of names; I am speaking simply of things. Nowadays, men do not pay the same nominal homage to the religion of enmity that they do to the religion of amity—the religion of amity

occupies the place of honor. But the real homage is paid in large measure, if not in the larger measure, to the religion of enmity. The religion of enmity nearly all men actually believe. The religion of amity most of them merely believe they believe. In some discussion, say, about international affairs, remind them of certain precepts contained in the creed they profess, and the most you get is a tepid assent. Now, let the conversation turn on the "tunding" at Winchester, or on the treatment of Indian mutineers, or on the Jamaica business; and you find that, while the precepts tepidly assented to were but nominally believed, quite opposite precepts are believed undoubtingly and defended with fervor.

Curiously enough, to maintain these antagonist religions, which in our transitional state are both requisite, we have adopted from two different races two different cults. From the books of the Jewish New Testament we take our religion of amity. Greek and Latin epics and histories serve as gospels for our religion of enmity. In the education of our youth we devote a small portion of time to the one, and a large portion of time to the other. And, as though to make the compromise effectual, these two cults are carried on in the same places by the same teachers. At our Public Schools, as also at many other schools, the same men are priests of both religions. The nobility of self-sacrifice, set forth in Scripture-lessons and dwelt on in sermons, is made conspicuous every seventh day; while during the other six days the nobility of sacrificing others is exhibited in glowing words. The sacred duty of blood-revenge, which, as existing savages show us, constitutes the religion of enmity in its primitive form—which, as shown us in ancient literature, is enforced by divine sanction, or rather by divine command, as well as by the opinion of men—is the duty which during the six days is deeply stamped on natures quite ready to receive it; and then something is done toward obliterating the stamp, when, on the seventh day, vengeance is interdicted.

A priori, it might be thought impossible that men should continue through life holding two doctrines which are mutually destructive. But their ability to compromise between conflicting beliefs is very remarkable—remarkable, at least, if we suppose them to put their conflicting beliefs side by side; not so remarkable if we recognize the fact that they do not put them side by side. A late distinguished physicist, whose science and religion seemed to his friends irreconcilable, retained both for the reason that he deliberately refused to compare the propositions of the one with those of the other. To speak in metaphor—when he entered his oratory he shut the door of his laboratory; and when he entered his laboratory he shut the door of his oratory. It is because they habitually do something similar, that men live so contentedly under this logically-indefensible compromise between their two creeds. As the intelligent child, propounding to his seniors puzzling theological questions, and meeting many rebuffs, eventually ceases

to think about difficulties of which he can get no solutions; so, a little later, the contradictions between the things taught to him in school and in church, at first startling and inexplicable, become by-and-by familiar, and no longer attract his attention. Thus while growing up he acquires, in common with all around him, the habit of using first one and then the other of his creeds as the occasion demands; and at maturity the habit has become completely established. Now he enlarges on the need for maintaining the national honor, and thinks it mean to arbitrate about an aggression instead of avenging it by war; and now, calling his servants together, he reads a prayer in which he asks God that our trespasses may be forgiven as we forgive the trespasses against us. That which he prays for as a virtue on the Sunday, he scorns as a vice on the Monday.

The religion of amity and the religion of enmity, with the emotions they respectively enlist, are important factors in sociological conclusions; and rational sociological conclusions can be produced only when both sets of factors come into play. We have to look at each cluster of social facts as a phase in a continuous metamorphosis. We have to look at the conflicting religious beliefs and feelings included in this cluster of facts as elements in this phase. We have to do more. We have to consider as transitional, also, the conflicting religious beliefs and feelings in which we are brought up, and which distort our views, not only of passing phenomena in our own society, but also of phenomena in other societies and in other times; and the aberrations they cause in our inferences have to be sought for and rectified. Of these two religions taught us, we must constantly remember that during civilization the religion of enmity is slowly losing strength, while the religion of amity is slowly gaining strength. We must bear in mind that at each stage a certain ratio between them has to be maintained. We must infer that the existing ratio is only a temporary one, and that the accompanying bias to this or that conviction respecting social affairs is temporary. And if we are to reach those unbiassed convictions which form parts of the Social Science, we can do it only by allowing for this temporary bias—only by analyzing and criticising the sentiments and dogmas they respectively sanctify, with the view of discovering how far these need qualification.

To see how greatly our opposite religions respectively pervert sociological beliefs, and how needful it is that the opposite perversions they cause should be corrected, we must here contemplate the extremes to which men are carried, now by the one and now by the other.

As from antagonist physical forces, as from antagonist emotions in each man, so from the antagonist social tendencies men's emotions create, there always results, not a medium state, but a rhythm between opposite states. The one force or tendency is not continuously

counterbalanced by the other force or tendency; but now the one greatly predominates, and presently by reaction there comes a predominance of the other. That which we are shown by variations in the prices of stocks, shares, or commodities, occurring daily, weekly, and in longer intervals—that which we observe in the alternation of manias and panics, caused by irrational hopes and absurd fears—that which diagrams of these variations express by the ascents and descents of a line, now to a great height and now to an equivalent depth, we discover in all social phenomena, moral and religious included. It is exhibited on a large scale and on a small scale—by rhythms extending over centuries and by rhythms of short periods. And we see it, not only in waves of conflicting feelings and opinions pervading societies as wholes, but also in the opposite excesses gone to by individuals and sects in the same society at the same time. There is never a balanced judgment and a balanced action, but always a cancelling of one another by contrary errors: "Men pair off in insane parties," as Emerson puts it. Something like rationality is finally obtained as a product of mutually-destructive irrationalities. As, for example, in the treatment of our criminals, there alternates or coexists an unreasoning severity with an unreasoning lenity: now we punish in a spirit of vengeance, now we pamper with a maudlin sympathy. At no time is there a due adjustment of penalty to transgression such as the course of Nature shows us—an inflicting of neither more nor less evil than the reaction which the action causes.

The religion of unqualified altruism, coming as it did to correct by an opposite excess the religion of unqualified egoism, exhibits to us this general law on a great scale. Against the doctrine of entire selfishness it sets the doctrine of entire self-sacrifice. In place of the aboriginal creed not requiring you to love your fellow-man at all, but insisting only that certain of your fellow-men you shall hate even to the death, there comes a creed directing that you shall in no case do any thing prompted by hate of your fellow-man, but shall love him as yourself. Nineteen centuries have since wrought some compromise between these opposite creeds. It has never been rational, however, but only empirical—mainly, indeed, unconscious compromise. There is not yet a distinct recognition of what truth each extreme stands for, and a perception that the two truths must be coördinated; but there is little more than a partial rectifying of excesses one way by excesses the other way. By these persons purely-egoistic lives are led. By those, altruism is carried to the extent of bringing on ill health and premature death. Even on comparing the acts of the same individual, we find, not an habitual balance between the two tendencies, but now an effort to inflict great evil on some foreign aggressor or some malefactor at home, and now a disproportioned sacrifice on behalf of one often quite unworthy of it. That altruism is right, but that egoism is also right, and that there requires a continual compromise between

the two, is a conclusion which but few consciously formulate and still fewer avow.

Yet the untenability of the doctrine of self-sacrifice in its extreme form is conspicuous enough; and is tacitly admitted by all in their ordinary inferences and daily actions. Work, enterprise, invention, improvement, as they have gone on from the beginning and are going on now, depend on the principle that, among citizens severally having unsatisfied wants, each cares more to satisfy his own wants than to satisfy the wants of others. The fact, that industrial activities proceed on this basis, being recognized, the inevitable implication is that unqualified altruism would dissolve all existing social organizations: leaving the onus of proof that absolutely-alien social organizations would act. That they would not act becomes clear on supposing the opposite principle in force. Were A to be careless of himself, and to care only for the welfare of B, C, and D, while each of these, paying no attention to his own needs, busied himself in supplying the needs of the others, this roundabout process, besides being troublesome, would very ill meet the requirements of each, unless each could have his neighbor's consciousness. And after observing this we must infer that a certain predominance of egoism over altruism is beneficial, and that in fact no other arrangement would answer. Do but ask what would happen if, of A, B, C, D, etc., each declined to have a gratification, in his anxiety that some one else should have it, and that the some one else similarly persisted in refusing it out of sympathy with his fellows—do but contemplate the resulting confusion and cross-purposes and loss of gratification to all, and you will see that pure altruism would bring things to a dead-lock just as much as pure egoism. In truth, nobody ever dreams of acting out the altruistic theory in all the relations of life. The Quaker who proposes to accept literally, and to practise, the precepts of Christianity, carries on his business on egoistic principles just as much as his neighbors. Though, nominally, he holds that he is to take no thought for the morrow, his thought for the morrow betrays as distinct an egoism as that of men in general; and he is conscious that to take as much thought for the morrows of others would be ruinous to him and eventually mischievous to all.

While, however, no one is entirely altruistic—while no one really believes an entirely altruistic life to be practicable, there continues the tacit assertion that conduct *ought* to be entirely altruistic. It does not seem to be suspected that pure altruism is actually wrong. Brought up, as each is, in the nominal acceptance of a creed which wholly subordinates egoism to altruism, and gives sundry precepts that are absolutely altruistic, each citizen, while ignoring these in his business, and tacitly denying them in various opinions he utters, daily gives to them lip-homage, and supposes that acceptance of them is required of him though he finds it impossible. Feeling that he cannot call them

in question without calling in question his religion as a whole, he pretends to others and to himself that he believes them—believes things which in his innermost consciousness he knows he does not believe. He professes to think that entire self-sacrifice must be right, though dimly conscious that it would be fatal.

If he had the courage to think out clearly what he vaguely perceives, he would discover that self-sacrifice, passing a certain limit, entails evil on all—evil on those for whom sacrifice is made as well as on those who make it. While a continual giving-up of pleasures and continual submission to pains is physically injurious, so that its final outcome is debility, disease, and abridgment of life, the continual acceptance of benefits at the expense of a fellow-being is morally injurious. Just as much as unselfishness is cultivated by the one, selfishness is cultivated by the other. If to surrender a gratification to another is noble, readiness to accept the gratification so surrendered is ignoble; and if repetition of the one kind of act is elevating, repetition of the other kind of act is degrading. So that, though up to a certain point altruistic action blesses giver and receiver, beyond that point it curses giver and receiver—physically deteriorates the one and morally deteriorates the other. Every one can remember cases where greediness for pleasures, reluctance to take trouble, and utter disregard of those around, have been perpetually increased by unmeasured and ever-ready kindnesses; while the unwise benefactor has shown by languid movements and pale face the debility consequent on disregard of self: the outcome of the policy being destruction of the worthy in making worse the unworthy.

The absurdity of unqualified altruism becomes, indeed, glaring enough on remembering that it can be extensively practised only if in the same society there coexist one moiety altruistic and one moiety egoistic. Only those who are intensely selfish will allow their fellows habitually to behave to them with extreme unselfishness. If all are duly regardful of others, there are none to accept the sacrifices which others are ready to make. If a high degree of sympathy characterizes all, no one can be so unsympathetic as to let another receive positive or negative injury that he may benefit. So that pure altruism in a society implies a nature which makes pure altruism impossible, from the absence of those toward whom it may be exercised!

Equally untenable does the doctrine show itself when looked at from another point of view. If life and its gratifications are valuable in another, they are equally valuable in self. There is no total increase of happiness if as much is gained by one as is lost by another; and if, as continually happens, the gain is not equal to the loss—if the recipient, already inferior, is further demoralized by habitual acceptance of sacrifices, and so made less capable of happiness (which he inevitably is)—the total amount of happiness is diminished: benefactor and beneficiary are both losers.

The maintenance of the individuality is thus demonstrably a duty. The assertion of personal claims is essential; both as a means to self-happiness, which is a unit in the general happiness, and as a means to furthering the general happiness altruistically. Resistance to aggression is not simply justifiable but imperative. Non-resistance is at variance with altruism and egoism alike. The extreme Christian theory, which no one acts upon, which no one really believes, but which most tacitly profess and a few avowedly profess, is as logically indefensible as it is impracticable.

The religion of amity, then, taken by itself, is incomplete—it needs supplementing. The doctrines it inculcates and the sentiments it fosters, arising by reactions against opposite doctrines and sentiments, run into extremes the other way.

Let us now turn to these opposite doctrines and sentiments, inculcated and fostered by the religion of enmity, and note the excesses to which they run.

Worthy of highest admiration is the "Tasmanian devil," which, fighting to the last gasp, snarls with its dying breath. Admirable, too, though less admirable, is our own bull-dog—a creature said sometimes to retain its hold even when a limb is cut off. To be admired also for their "pluck," perhaps nearly in as great a degree, are some of the carnivora, as the lion and the tiger; since when driven to bay they fight against great odds. Nor should we forget the game-cock, supplying as it does a word of eulogy to the crowd who witness the hanging of a murderer, and who half condone his crime if he "dies game." Below these animals come mankind; some of whom, indeed, as the American Indians, bear tortures without groaning. And then, considerably lower, must be placed the civilized man; who, fighting up to a certain point, and bearing considerable injury, ordinarily yields when further fighting is useless.

Is the reader startled by this classification? Why should he be? It is but a literal application of that standard of worth tacitly assumed by most, and by some deliberately avowed. Obviously it is the standard of worth believed in by M. Gambetta, who, after bloodshed carried to the extent of prostrating France, lately reproached the French Assembly by saying, "You preferred peace to honor; you gave five milliards and two provinces." And there are not a few among ourselves who so thoroughly agree in M. Gambetta's feeling, that this utterance of his has gone far to redeem him in their estimation. If the reader needs encouragement to side with such, plenty more may be found for him. The Staffordshire collier, enjoying the fighting of dogs when the fighting of men is not to be witnessed, would doubtless take the same view. In the slums of Whitechapel and St. Giles's, among leaders of "the fancy," it is an unhesitating belief that pluck and endurance are the highest of attributes; and probably most

readers of *Bell's Life in London* would concur in this belief. Moreover, if he wants further sympathy to support him, he may find entire races ready to give it; especially that noble race of cannibals, the Feejeeans, among whom bravery is so highly honored that, on their return from battle, the triumphant warriors are met by the women, who place themselves at their unrestricted disposal. So that whoever inclines to adopt this measure of superiority will find many to side with him—that is, if he likes his company.

Seriously, is it not amazing that civilized men should especially pride themselves on a quality in which they are exceeded by inferior varieties of their own race, and still more exceeded by inferior animals? Instead of regarding a man as manly in proportion as he possesses moral attributes distinctively human, we regard him as manly in proportion as he shows an attribute possessed in greater degrees by beings from whom we derive our words of contempt. It was lately remarked by Mr. Greg that we take our point of honor from the prize-ring; but we do worse—we take our point of honor from beasts. Nay, we take it from a beast inferior to those we are familiar with; for the "Tasmanian devil," in structure and intelligence, stands on a much lower level of brutality than our lions and bull-dogs.

That resistance to aggression is to be applauded, and that the courage implied by resistance is to be valued and admired, may be fully admitted while denying that courage is to be regarded as the supreme virtue. A large endowment of it is essential to a complete nature; but so are large endowments of other things which we do not therefore make our measures of worth. A good body, well grown, well proportioned, and of such quality in its tissues as to be enduring, should bring, as it does bring, its share of admiration. Admirable, too, in their ways, are good stomach and lungs, as well as a vigorous vascular system; for without these the power of self-preservation and the power of preserving others will fall short. To be a fine animal is, indeed, essential to many kinds of achievement; and courage, which is a general index of an organization capable of satisfying the requirements, is rightly valued for what it implies. Courage is, in fact, a feeling that grows by accumulated experiences of successful dealings with difficulties and dangers; and these successful dealings are proofs of competence in strength, agility, quickness, endurance, etc. No one will deny that perpetual failures, resulting from incapacity of one kind or other, produce discouragement; or that repeated triumphs, which are proofs of capacity, so raise the courage that there comes a readiness to encounter greater difficulties. The fact that a dose of brandy, by stimulating the circulation, produces "Dutch courage," as it is called, joined with the fact well known to medical men, that heart-disease brings on timidity, is of itself enough to show that bravery is the natural correlative of ability to cope with circumstances of peril. But while we are thus taught that, in admiring cour-

age, we are admiring physical superiorities and those superiorities of mental faculty which give fitness for dealing with emergencies, we are also taught that, unless we rank highest the bodily powers and those powers which directly conduce to self-preservation, we cannot say that courage is the highest attribute, and that the degree of it should be our standard of honor.

That an over-estimate of courage is appropriate to our phase of civilization may be very true. It is beyond doubt that, during the struggle for existence among nations, it is needful that men should admire extremely the quality without which there can be no success in the struggle. While, among neighboring nations, we have one in which all the males are trained for war—while the sentiment of this nation is such that students slash one another's faces in duels about trifles, and are admired for their scars, especially by women—while the military ascendency it tolerates is such that, for ill-usage by soldiers, ordinary citizens have no adequate redress—while the government is such that, though the monarch as head of the Church condemns duelling as irreligious, and as head of the Law forbids it as a crime, yet as head of the army he insists on it to the extent of expelling officers who will not fight duels—while, I say, we have a neighboring nation thus characterized, something of a kindred character in appliances, sentiments, and beliefs, has to be maintained among ourselves. When we find another neighboring nation believing that no motive is so high as the love of glory, and no glory so great as that gained by successful war—when we perceive the military spirit so pervading this nation that it loves to clothe its children in *quasi*-military costume—when we find one of its historians writing that the French army is the great civilizer, and one of its generals lately saying that the army is the soul of France—when we see that the vital energies of this nation run mainly to teeth and claws, and that it quickly grows new sets of teeth and claws in place of those pulled out; it is needful that we, too, should keep our teeth and claws in order, and should maintain ideas and feelings adapted to the effectual use of them. There is no gainsaying the truth that, while the predatory instincts continue prompting nations to rob one another, destructive agencies must be met by antagonist destructive agencies; and, that this may be done, honor must be given to the men who act as destructive agents, and there must be an exaggerated estimate of the attributes which make them efficient.

It may be very needful, therefore, that our boys should be accustomed to harsh treatment, giving and receiving brutal punishments without too nice a consideration of their justice. It may be that, as the Spartans and as the North-American Indians, in preparation for warfare, subjected their young men to tortures, so should we; and thus, perhaps, the "education of a gentleman" may properly include giving and receiving "hacking" of the shins at foot-ball: boot-toes

being purposely made heavy that they may inflict greater damage. So, too, it may be well that boys should all in turn be subject to the tender mercies of elder boys, with whose thrashings and kickings the masters decline to interfere; even though they are sometimes carried to the extent of maiming for life. Possibly, too, it is needful that each boy should be disciplined in submission to any tyrant who may be set over him, by finding that appeal brings additional evils. That each should be made callous, morally as well as physically, by the bearing of frequent wrongs, and should be made yet more callous when, coming into power, he inflicts punishments as whim or spite prompts, may also be desirable. Nor, perhaps, can we wholly regret that confusion of moral ideas which results when breaches of conventional rules bring penalties as severe as are brought by acts morally wrong. For war does not consist with keen sensitiveness, physical or moral. Reluctance to inflict injury, and reluctance to risk injury, would equally render it impossible. Scruples of conscience respecting the rectitude of their cause would paralyze officers and soldiers. So that a certain brutalization has to be maintained during our passing phase of civilization. It may, indeed, be that "the Public School spirit," which, as truly said, is carried into our public life, is not the most desirable for a free country. It may be that early subjection to despotism, and early exercise of uncontrolled power, are not the best possible preparations for legislators. It may be that those, who, on the magistrate's bench, have to maintain right against might, could be better trained than by submission to violence and subsequent exercise of violence. And it may be that some other discipline than that of the stick would be desirable for men who officer the press and guide public opinion on questions of equity. But, doubtless, while national antagonisms continue strong and national defence a necessity, there is a fitness in this semi-military discipline, with pains and bruises to uphold it. And a duly-adapted code of honor has the like defence.

Here, however, if we are to free ourselves from transitory sentiments and ideas, so as to be capable of framing scientific conceptions, we must ask what warrant there is for this exaltation of the destructive activities and of the qualities implied by them? We must ask how it is possible for men rightly to pride themselves on attributes possessed in a higher degree by creatures so much lower? We must consider whether, in the absence of a religious justification, there is any ethical justification for the idea that the most noble traits are such as cannot be displayed without the infliction of pain and death. When we do this, we are obliged to admit that the religion of enmity in its unqualified form is as indefensible as the religion of amity in its unqualified form. Each proves itself to be one of those insane extremes out of which there comes a sane mean by union with its opposite. The two religions stand respectively for the claims of self and the claims of others. The one religion holds it glorious to resist

aggression, and, while risking death in doing this, to inflict death upon others. The other religion teaches that the glory is in not resisting aggression, and in yielding to others while not asserting the claims of self. A civilized humanity will render the one glory just as impossible of achievement as the other. A diminishing egoism and an increasing altruism must make each of these opposite kinds of honor unattainable. For such an advance implies a cessation of those aggressions which make possible the nobility of resistance; while it implies a refusal to accept those sacrifices without which there cannot be the nobility of self-sacrifice. The two extremes must cancel; leaving a moral code and a standard of honor free from irrational excesses. Along with a latent self-assertion, there will go a readiness to yield to others, kept in check by the refusal of others to accept more than their due.

And now, having noted the perversions of thought and sentiment fostered by the religion of amity and the religion of enmity, under which we are educated in so chaotic a fashion, let us go on to note the ways in which these affect sociological conceptions. Certain important truths, apt to be shut out from the minds of the few who are unduly swayed by the religion of amity, may first be set down.

One of the facts difficult to reconcile with current theories of the Universe is, that high organizations, throughout the animal kingdom, habitually serve to aid destruction or to aid escape from destruction. If we hold to the ancient view, we must say that high organization has been deliberately devised for such purposes. If we accept the modern view, we must say that high organization has been evolved by the exercise of destructive activities during immeasurable periods of the past. Here we choose the last alternative. To the never-ceasing efforts to catch and eat, and the never-ceasing endeavors to avoid being caught and eaten, is to be ascribed the development of the various senses and the various motor organs directed by them. The bird of prey with the keenest vision has, other things equal, survived when members of its species that did not see so far died from want of food; and, by such survivals, keenness of vision has been made greater in course of generations. The fleetest members of an herbivorous herd, escaping when the slower fell victims to a carnivore, left posterity; among which, again, those with the most perfectly-adapted limbs survived: the carnivores themselves being at the same time similarly disciplined and their speed increased. So, too, with intelligence. Sagacity that detected a danger which stupidity did not perceive, lived and propagated; and the cunning which hit upon a new deception, and so secured prey not otherwise to be caught, left posterity where a smaller endowment of cunning failed. This mutual perfecting of pursuer and pursued, acting upon their entire organizations, has been going on throughout all time; and human beings have

been subject to it just as much as other beings. Warfare among men, like warfare among animals, has had a large share in raising their organizations to a higher stage. Here are some of the various ways in which it has worked:

In the first place, it has had the effect of continually extirpating races which, for some reason or other, were least fitted to cope with the conditions of existence they were subject to. The killing-off of relatively-feeble tribes, or tribes relatively wanting in endurance, or courage, or sagacity, or power of coöperation, must have tended ever to maintain, and occasionally to increase, the amounts of life-preserving powers possessed by men.

Beyond this average advance caused by destruction of the least-developed races and the least-developed individuals, there has been an average advance caused by inheritance of those further developments due to functional activity. Remember the skill of the Indian in following a trail, and remember that under kindred stimuli many of his perceptions and feelings and bodily powers have been habitually taxed to the uttermost, and it becomes clear that the struggle for existence between neighboring tribes has had an important effect in cultivating faculties of various kinds. Just as, to take an illustration from among ourselves, the skill of the police cultivates cunning among burglars, which, again, leading to further precautions, generates further devices to evade them; so, by the unceasing antagonisms between human societies, small and large, there has been a mutual culture of an adapted intelligence, a mutual culture of certain traits of character not to be undervalued, and a mutual culture of bodily powers.

A large effect, too, has been produced upon the development of the arts. In responding to the imperative demands of war, industry made important advances and gained much of its skill. Indeed, it may be questioned whether, in the absence of that exercise of manipulative faculty which the making of weapons originally gave, there would ever have been produced the tools required for developed industry. If we go back to the Stone-Age, we see that implements of the chase and implements of war are those showing most labor and dexterity. If we take still-existing human races which were without metals when we found them, we see in their skilfully-wrought stone clubs, as well as in their large war-canoes, that the needs of defence and attack were the chief stimuli to the cultivation of arts afterward available for productive purposes. Passing over intermediate stages, we may note in comparatively-recent stages the same relation. Observe a coat-of-mail, or one of the more highly-finished suits of armor—compare it with articles of iron and steel of the same date; and there is evidence that these desires to kill enemies and escape being killed, more extreme than any other, have had great effects on those arts of working in metal to which most other arts owe their progress. The like relation

is shown us in the uses made of gunpowder. At first a destructive agent, it has become an agent of immense service in quarrying, mining, railway-making, etc.

A no less important benefit, bequeathed by war, has been the formation of large societies. By force alone were small nomadic hordes welded into large tribes; by force alone were large tribes welded into small nations; by force alone have small nations been welded into large nations. While the fighting of societies usually maintains separateness, or by conquest produces only temporary unions, it produces, from time to time, permanent unions; and as fast as there are formed permanent unions of small into large, and then of large into still larger, industrial progress is furthered in three ways. Hostilities, instead of being perpetual, are broken by intervals of peace. When they occur, hostilities do not so profoundly derange the industrial activities. And there arises the possibility of carrying out the division of labor much more effectually. War, in short, in the slow course of things, brings about a social aggregation which furthers that industrial state at variance with war; and yet nothing but war could bring about this social aggregation. These two truths, that without war large aggregates of men cannot be formed, and that without large aggregates of men there cannot be a developed industrial state, are illustrated in all places and times. Among existing uncivilized and semi-civilized races, we everywhere find that union of small societies by a conquering society is a step in civilization. The records of peoples now extinct show us this with equal clearness. On looking back into our own history, and into the histories of neighboring nations, we similarly see that only by coercion were the smaller feudal governments so subordinated as to secure internal peace. And, even lately, the long-desired consolidation of Germany, if not directly effected by "blood and iron," as Bismarck said it must be, has been indirectly effected by them. The furtherance of industrial development by aggregation is no less manifest. If we compare a small society with a large one, we get clear proof that those processes of coöperation by which social life is made possible assume high forms only when the numbers of the coöperating citizens are great. Ask of what use a cloth-factory, supposing they could have one, would be to the members of a small tribe, and it becomes manifest that, producing as it would in a single day a year's supply of cloth, the vast cost of making it and keeping it in order could never be compensated by the advantage gained. Ask what would happen were a shop like Stewart's, in New York, supplying all textile products, set up in a village, and you see that the absence of a sufficiently-extensive distributing function would negative its continuance. Ask what sphere a bank would have had in the Old-English period, when nearly all people grew their own food and wove their own wool, and it becomes obvious that the various appliances for facilitating exchange can grow up only when a community becomes so

large that the amount of exchange to be facilitated is great. Hence, unquestionably, that integration of societies effected by war has been a needful preliminary to industrial development, and consequently to developments of other kinds—Science, the Fine Arts, etc.

Industrial habits too, and habits of subordination to social requirements, are indirectly brought about by the same cause. The truth that the power of working continuously, wanting in the aboriginal man, could be established only by that persistent coercion to which conquered and enslaved tribes are subject, has become trite. An allied truth is, that only by a discipline of submission, first to an owner, then to a personal governor, presently to government less personal, then to the embodied law proceeding from government, could there eventually be reached submission to that code of moral law by which the civilized man is more and more restrained in his dealings with his fellows.

Such being some of the important truths usually ignored by men too exclusively influenced by the religion of amity, let us now glance at the no less important truths to which men are blinded by the religion of enmity.

Though, during barbarism and the earlier stages of civilization, war has the effect of exterminating the weaker societies, and of weeding out the weaker members of the stronger societies, and thus in both ways furthering the development of those valuable powers, bodily and mental, which war brings into play; yet, during the later stages of civilization, the second of these actions is reversed. So long as all adult males have to bear arms, the average result is that those of most strength and quickness survive, while the feebler and slower are slain; but when the industrial development has become such that only some of the adult males are draughted into the army, the tendency is to pick out and expose to slaughter the best-grown and healthiest; leaving behind the physically inferior to propagate the race. The fact that among ourselves, though the number of soldiers raised is not relatively large, many recruits are rejected by the examining surgeons, shows that the process inevitably works toward deterioration. Where, as in France, conscriptions have gone on generation after generation, taking away the finest men, the needful lowering of the standard proves how disastrous is the effect on those animal qualities of a race which form a necessary basis for all higher qualities. If the depletion is indirect also—if there is such an overdraw on the energies of the industrial population that a large share of heavy labor is thrown on the women, whose systems are taxed simultaneously by hard work and child-bearing, a further cause of physical degeneracy comes into play: France again supplying an example. War, therefore, after a certain stage of progress, instead of furthering bodily development and the development of certain mental powers, becomes a cause of retrogression.

In like manner, though war, by bringing about social consolidations, indirectly favors industrial progress and all its civilizing consequences, yet the direct effect of war on industrial progress is repressive. It is repressive as necessitating the abstraction of men and materials that would otherwise go to industrial growth; it is repressive as deranging the complex interdependencies among multitudinous, productive, and distributive agencies; it is repressive as draughting off much administrative and constructive ability, which would else have gone to improve the industrial arts and the industrial organization. And if we contrast the absolutely-military Spartans with the partially-military Athenians in their respective attitudes toward culture of every kind, or call to mind the contempt shown for the pursuit of knowledge in purely-military times like those of feudalism, we cannot fail to see that predominant warlike activity is at variance not only with industrial development, but also with the higher intellectual developments that aid it and are aided by it.

So, too, with the effects wrought on the moral nature. While war, by the discipline it gives soldiers, directly cultivates the habit of subordination, and does the like indirectly by establishing strong and permanent governments; and while in so far it cultivates attributes that are not only temporarily essential, but are steps toward attributes that are permanently essential; yet it does this at the cost of maintaining, and sometimes increasing, detrimental attributes—attributes intrinsically antisocial. The aggressions which selfishness prompts—aggressions which, in a society, have to be restrained by some power that is strong in proportion as the selfishness is intense, can diminish only as fast as selfishness is held in check by sympathy; and perpetual warlike activities repress sympathy: nay, they do worse—they cultivate aggressiveness to the extent of making it a pleasure to inflict injury. The citizen made callous by the killing and wounding of enemies, inevitably brings his callousness with him into society. Fellow-feeling, habitually trampled out in military conflicts, cannot at the same time be active in the relations of civil life. In proportion as the giving pain to others is made a habit during war, it will remain a habit during peace: inevitably producing, in the behavior of citizens to one another, antagonisms, crimes of violence, and multitudinous aggressions of minor kinds, tending toward a disorder that calls for a coercive government. Nothing like a high type of social life is possible without a type of human character in which the promptings of egoism are duly restrained by regard for others. The necessities of war imply absolute self-regard and absolute disregard of certain others. Inevitably, therefore, the civilizing discipline of social life is antagonized by the uncivilizing discipline of the life war involves. So that, beyond the direct mortality and miseries entailed by war, it entails other mortality and miseries by maintaining antisocial sentiments in citizens.

Taking the most general view of the matter, we may say that only when the sacred duty of blood-revenge, constituting the religion of the savage, becomes less sacred, does there arise a possibility of emergence from the deepest barbarism. Only as fast as the retaliation, which for a murder on one side inflicts a murder or murders on the other, becomes less imperative, is it possible for larger aggregates of men to hold together and civilization to commence. And so, too, out of lower stages of civilization higher ones can emerge, only as there diminishes this pursuit of international revenge and re-revenge, which the code we inherit from the savage insists upon. Such advantages, bodily and mental, as the race derives from the discipline of war, are outbalanced by the disadvantages, physical and moral, but especially moral, which result after a certain stage of progress is reached. Severe and bloody as the process is, the killing-off of inferior races and inferior individuals leaves a balance of benefit to mankind during phases of progress in which the moral development is low, and there are no quick sympathies to be continually seared by the infliction of pain and death. But as there arise higher types of societies, implying types of individual character fitted for closer coöperation, the destructive activities exercised by such higher societies have injurious reactive effects on the moral natures of their members, which outweigh the benefit resulting from extirpation of inferior races. After this stage has been reached, the purifying process, continuing still an important one, remains to be carried on by industrial war—by a competition of societies during which the best, physically, emotionally, and intellectually, spread most, and leave the least capable to disappear gradually, from failing to leave an adequately-numerous posterity.

Those educated in the religion of enmity—those who during boyhood, when the instincts of the savage are dominant, have revelled in the congenial ideas and sentiments which classic poems and histories yield so abundantly, and have become confirmed in the belief that war is virtuous and peace ignoble—are naturally blind to truths of this kind. Rather should we say, perhaps, that they have never turned their eyes in search of such truths. And their bias is so strong that nothing more than a nominal recognition of such truths is possible to them; if even this. What perverted conceptions of sociological phenomena this bias produces, may be seen in the following passage from Gibbon:

> "It was scarcely possible that the eyes of contemporaries should discover in the public felicity the causes of decay and corruption. *The long peace, and the uniform government of the Romans*, had introduced a slow and secret poison into the vitals of the empire."[1]

In which sentences there is involved the abstract proposition that in proportion as men are long held together in that mutual dependence

[1] "Decline and Fall," chapter ii.

which social coöperation implies, they will become less fit for mutual dependence and coöperation—the society will tend toward dissolution. While, in proportion as they are habituated to antagonism and to destructive activities, they will become better adapted to activities requiring union and agreement.

Thus the two opposite codes in which we are educated, and the sentiments enlisted on behalf of their respective precepts, inevitably produce misinterpretations of social phenomena. Instead of acting together, now this and now the other sways the beliefs; and, instead of consistent, balanced conclusions, there results a jumble of contradictory conclusions.

It is time, not only with a view to right thinking in social science, but with a view to right acting in daily life, that this acceptance in their unqualified forms, of two creeds which contradict one another completely, should come to an end. Is it not a folly to go on pretending to ourselves and others that we believe certain perpetually-repeated maxims of entire self-sacrifice, which we daily deny by our business activities, by the steps we take to protect our persons and property, by the approval we express of resistance against aggression? Is it not a dishonesty to repeat, in tones of reverence, maxims which we not only refuse to act out, but dimly see would be mischievous if acted out? Every one must admit that the relation between parent and child is one in which altruism is pushed as far as is practicable. Yet even here there needs a predominant egoism. The mother can suckle her infant only on condition that she has habitually gratified her appetite in due degree. And there is a point beyond which sacrifice of herself is fatal to her infant. The bread-winner, too, on whom both depend—is it not undeniable that wife and child can be altruistically treated by their protector, only on condition that he is duly egoistic in his transactions with his fellow-citizens? If the dictate, "Live for self," is wrong in one way, the opposite dictate, "Live for others," is wrong in another way. The rational dictate is—live for self and others. And, if we all do actually believe this, as our conduct conclusively proves, is it not better for us distinctly to say so, rather than continue enunciating principles which we do not and cannot practise; and thus bringing moral teaching itself into discredit?

On the other hand, it is time that a ferocious egoism, which remains unaffected by this irrational altruism, hppocritically professed but not believed, should be practically modified by a rational altruism. This sacred duty of blood-revenge, insisted on by the still-vigorous religion of enmity, needs qualifying actually and not verbally. Instead of senselessly reiterating in catechisms and church services the duty of doing good to those that hate us, while an undoubting belief in the duty of retaliation is implied by our parliamentary debates, the articles in our journals, and the conversations over our tables, it would

be wiser and more manly to consider how far the first should go in mitigation of the last. Is it stupidity or is it moral cowardice which leads men to continue professing a creed that makes self-sacrifice a cardinal principle, while they urge the sacrificing of others, even to the death, when they trespass against us? Is it blindness, or is it an insane inconsistency, which makes them regard as most admirable the bearing of evil for the benefit of others, while they lavish admiration on those who, out of revenge, inflict great evils in return for small ones suffered? Surely our barbarian code of right needs revision, and our barbarian standard of honor should be somewhat changed. Let us deliberately recognize what good they represent and what mixture of bad there is with it. Courage is worthy of respect when displayed in the maintenance of legitimate claims and in the repelling of aggressions, bodily or other. Courage is worthy of yet higher respect when danger is faced in defence of claims common to self and others, as in resistance to invasion. Courage is worthy of the highest respect when risk to life or limb is dared in defence of others; and becomes grand when those others have no claims of relationship, and still more when they have no claims of race. But though a bravery which is altruistic in its motive is a trait we cannot too highly applaud, and though a bravery which is legitimately egoistic in its motive is praiseworthy, the bravery that is prompted by aggressive egoism is not praiseworthy. The admiration accorded to the "pluck" of one who fights in a base cause is a vicious admiration, essentially demoralizing to those who feel it. Like the physical powers, courage, which is a concomitant of these, is to be regarded as a servant of the higher emotions—very valuable, indispensable even, in its place; and to be honored when discharging its function in subordination to these higher emotions. But otherwise not more to be honored than the like attribute as seen in brutes.

Quite enough has been said to show that there must be a compromise between the opposite standards of conduct on which the religions of amity and enmity respectively insist, before there can be scientific conceptions of social phenomena. Even on passing affairs, such as the proceedings of philanthropic bodies and the dealings of nation with nation, there cannot be rational judgments without a balance between the self-asserting emotions and the emotions which put a limit to self-assertion, with an adjustment of the corresponding beliefs. Still less can there be rational judgments of past social evolution, or of social evolution in the future, if the opposing actions which these opposing creeds sanction are not both continuously recognized as essential. No mere impulsive recognition, now of the purely-egoistic doctrine and now of the purely-altruistic one, will suffice. The curve described by a planet cannot be understood by thinking at one moment of the centripetal force and at another moment of the tangential force; but the two must be kept before con-

sciousness as acting simultaneously. And similarly, to understand social progress in the vast sweep of its course, there must be ever present to the mind the egoistic and the altruistic forces as coöperative factors equally indispensable, and neither of them to be ignored or reprobated.

The criticism likely to be passed on this chapter, that "The Educational Bias" is far too comprehensive a title for it, is quite justifiable. There are in truth few, if any, of the several kinds of bias, that are not largely, or in some measure, caused by education—using this word in an extended sense. As, however, all of them could not be dealt with in one chapter, it seemed best to select these two opposite forms of bias which are so directly traceable to teachings of opposite dogmas, and fosterings of opposite sentiments, during early life. Merely recognizing the fact that education has much to do with the other kinds of bias, we may now most conveniently deal with these, each under its specific title.

THE STRENGTH OF TIMBER.[1]

By JOHN ANDERSON, C. E., LL. D., F. R. S. E.

ALTHOUGH it is of less importance to investigate the strength of timber at the present time than it was formerly, in consequence of the diminished use of that material in permanent structures, and the more general employment of iron, still it will always be a very valuable material for certain purposes, and ought not to be neglected. Timber is variously used, even now, in permanent works, and is applied much more extensively in temporary structures—such as centerings and scaffolding. Hence its properties are well worthy of careful attention; and the student should be familiar, not only with the external appearance of the principal kinds of wood, but also with their relative strength, stiffness, toughness, and durability.

One of the most obvious inferences to be drawn from the experiments previously recorded is, that very wide variations exist in the strength and other elastic properties of different metals, and even of different specimens of the same metal. If we could investigate the properties of timber with the same care which has been bestowed on the metals, we should find that there is an even greater variation in the properties of different kinds of wood. This arises, in part, from the fact that timber is much affected by a number of external and internal conditions, during its growth and seasoning, and in its subsequent treatment, which gradually modify and change its properties.

[1] From "Strength of Materials and Structures." D. Appleton & Co.

It will only be necessary here to speak of the powers of resistance of a few among the many kinds of wood now employed in the mechanical arts. The greater number of the varieties of wood owe their commercial value to special characteristics, such as beauty of grain and capability of being polished—the description of which does not fall within the scope of the present article.

As a general rule, we may judge of the hardness of a wood by its specific gravity, if it is in its natural state. But the density may be increased by artificial compression, and this increase of density is generally accompanied by increase of strength. Some varieties of wood, as, for instance, *lignumvitæ*, are so dense that they sink in water, while some of the softer woods have not half the density of that fluid. The presence of gum or resin in any wood adds both to its strength and durability. Many woods will last a long time if kept constantly under water, but scarcely any wood is very durable when allowed to become wet and dry alternately.

The strength of a piece of timber depends upon the part of the tree from which it is taken. Up to a certain age, the heart of the tree is the best; after that period, it begins to fail gradually. The worst part of a tree is the sap-wood, which is next the bark. It is softer than the other parts of the wood, and is liable to premature decay. The deleterious component of the sap-wood is absorbed, if the tree is allowed to grow for a longer period, and in time the old sap-wood becomes proper timber-fibre similar to heart-wood. Hence, the goodness of a tree, for timber purposes, depends on the age at which the tree was cut down. When young, the heart-wood is the best; at maturity, with the exception of the sap-wood, the trunk is equally good throughout; and, when the tree is allowed to grow too long, the heart-wood is the first to show symptoms of weakness, and deteriorates gradually.

The best timber is secured by felling the tree at the age of maturity, which depends on its nature as well as on the soil and climate. The ash, beech, elm, and fir, are generally considered at their best when of 70 or 80 years' growth, and the oak is seldom at its best in less time than 100 years, but much depends on surrounding circumstances. As a rule, trees should not be cut before arriving at maturity, because there is then too much sap-wood, and the durability of the timber is much inferior to that of trees felled after they have arrived at their full development.

The strength of many woods is nearly doubled by the process of seasoning, hence it is very thriftless to use timber in a green state, as it is not only weak, but is exposed to continual change of bulk, form, and stability. After timber is cut, and before it is properly seasoned, the outside is found to crack and to split more than the inside of the mass, because it is more exposed to the desiccating effect of the surrounding atmosphere, but, as the outside dries, the air gradually finds its way to the interior. If timber is cut up by the saw when green,

and allowed to season or dry in a gradual manner, it is found to be the most durable. In the arts, however, artificial drying is often resorted to, as in the case of gun-stocks. These are put into a desiccating chamber, where a current of air at 90° or 100° is passed over them, at such a rate as to change the whole volume of air in the chamber every three minutes, and it is found that a year of seasoning may thus be saved. The walnut-wood is as good, after this process, as if the seasoning had been accomplished by time and exposure, and works more smoothly under the cutting instruments of the stock-machinery.

Wood will always warp after a fresh surface has been exposed, and will likewise change its form by the presence of any moisture, either from that contained in the atmosphere or from wetting the surface. The effect of moisture on dry wood is to cause the tubular fibres to swell; hence it is that, if a plank or board is wetted upon one side, the fibres there will be distended, and the plank, in consequence, must bend.

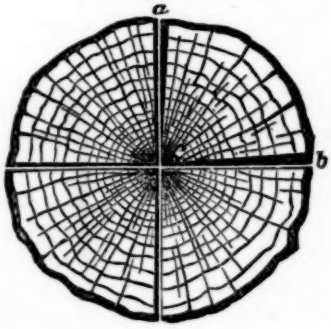
The natural law that governs the shrinking or contraction of timber is most important to practical men, but it is too often overlooked.

The amount of the shrinkage of timber in length, when seasoning, is so inconsiderable that it may in practice be disregarded. But the shrinkage in transverse directions is much greater, and presents some peculiarities which can only be explained by examining the structure of the wood, as resulting from its mode of growth. An examination of the end section of any exogenous tree, such as the beech or oak, will show the general arrangement of its structure. It consists of a mass of longitudinal fibrous tubes, arranged in irregular circles, which are bound together by means of radial plates or rays, which have been variously named: they are the "silver grain" of the carpenter, or the "medullary rays" of the botanist, and are in reality the same in their nature as the pith. The radial direction of these plates or rays, and the longitudinal disposition of the woody fibre, must be considered in order to understand the action of seasoning. For the lateral contraction or collapsing of the longitudinal fibrous or tubular part of the structure cannot take place without first tearing the medullary rays, hence the shrinking of the woody bundles finds relief by splitting the timber in radial lines from the centre parallel with the medullary rays, thereby enabling the tree to maintain its full diameter. If the entire mass of tubular fibre composing the tree were to contract bodily, then the medullary rays would, of necessity, have to be crushed in the radial direction to enable it to take place, and the timber would thus be as much injured in proportion as would be the case in crushing the wood in a longitudinal direction.

If an oak or beech tree is cut into four quarters, by passing the saw twice through the centre at right angles, before the splitting and contracting have commenced, the lines *a c* and *b c* in Fig. 1 would be of the same length, and at right angles to each other, or, in the tech-

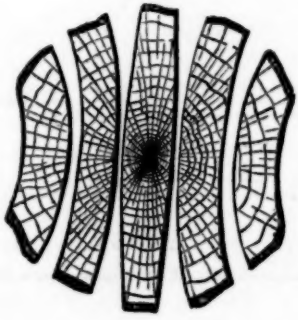
nical language of the workshop, they would be square; but, after being stored in a dry place, say for a year, a great change will be found to have taken place, both in the form and in some of the dimensions. The lines *a c* and *b c* will still be of the same length as before, but from *a* to *b* the wood will have contracted very considerably, and the two lines *a c* and *b c* will not be at right angles to each other, the angle being diminished by the portion shown in black in Fig. 1. The medullary rays are thus brought closer by the collapsing of the vertical fibres.

Fig. 1.



But, supposing that six parallel saw-cuts are passed through the tree, so as to form it into seven planks, what will be the behavior of the several planks? Consider the centre plank first. After due seasoning and contracting, it will be found that the middle of the board still retains the original thickness, from the resistance of the medullary rays, while the thickness will be gradually reduced toward the edges for want of support, and the entire breadth of the plank will be the

Fig. 2.



same as it was at first for the foregoing reasons, and as shown in Fig. 2. Then, taking the planks at each edge of the centre, by the same law their change and behavior will be quite different: they will still retain their original thickness at the centre, but will be a little reduced on each edge throughout, but the side next to the heart of the tree

will be pulled round or bent convex, while the outside will be the reverse, or hollow, and the plank will be considerably narrower throughout its entire length, more especially on the surface of the hollow side. Selecting the next two planks, they will be found to have lost none of their thickness at the centre, and very little of their thickness at the edges, but very much of their breadth as planks, and will be curved round on the heart-side and made hollow on the outside. Supposing some of these planks to be cut up into square prisms when in the green state, the shape that these prisms will assume after a period of seasoning will entirely depend on the part of the tree to which they belong, the greatest alteration would be perpendicular to the medul-

FIG. 3.

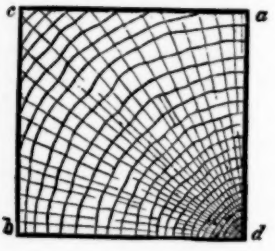
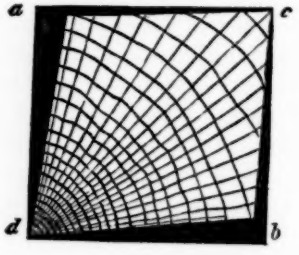


FIG. 4.



lary rays. Thus, if the square was originally near the outside, as seen in Fig. 3, then the effect will be as shown in Fig. 4, namely, contraction in the direction from *a* to *b*. After a year or two the square end of the prism will become rhomboidal, the distance between *c* and *d* being nearly the same as at first, but the other two edges brought closer together by the amount of their contraction. By understanding this natural law, it is comparatively easy to predict the future be-

FIG. 5.

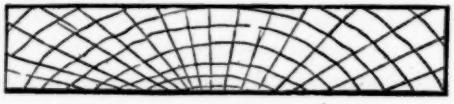
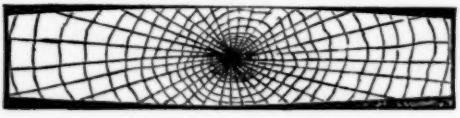


FIG. 6.



havior of a board or plank by carefully examining the end-wood, in order to ascertain the part of the log from which it has been cut, as the angle of the ring-growths and the medullary rays will show this, as in Figs. 5 and 6. If a plank has the appearance of the former, it must have been cut from the outside, and for many years it will grad-

ually shrink in the breadth; while the next plank, shown in Fig. 6, must have been derived from near the centre or heart of the tree, and it will not shrink in the breadth but in thickness, with the full dimension in the middle, but tapering to the edges.

The foregoing remarks apply more especially to the stronger exogenous woods, such as beech, oak, and the stronger firs. The softer woods, such as yellow Canadian pine, are governed by the same law; but, in virtue of their softness, another law comes into force, which to some degree affects their behavior, as the contracting power of the tubular wood has sufficient strength to crush the softer medullary rays to some extent, and hence the primary law is so far modified. But even with the softer woods, such as are commonly used in the construction of houses, if the law is carefully observed, the greater part of the evils of shrinking would be obviated. Hence, also, it is that when a round block, as a mast, is formed out of a tree, it retains its roundness because it contracts uniformly or nearly so, whereas, if a round spar is formed out of a quartering of the same tree it will become an oval, or otherwise contorted toward that shape.

It would not be in accordance with the object to enumerate all the woods that are employed in the arts, therefore a few only are selected, or such as are employed for purposes where strength is the primary object, viz., ash, beech, elm, fir, hornbeam, mahogany, oak, and teak.

Ash is a coarse wood, but possessed of considerable strength, and is distinguished for its great toughness and elasticity, and is usually employed where severe shocks and wrenches have to be encountered, such as for agricultural implements, the felloes and spokes of wheels, and the shafts of carriages, for hammer-shafts, and for spring purposes generally wherever wood is employed for that purpose.

From its great flexibility it is seldom employed where rigidity is a desideratum. The combination of strength with flexibility is the characteristic of ash, and when the wood is from a young tree, or a tree not too old, it is an invaluable wood in many respects; but as the tree becomes older, the change to brittleness sets in and soon renders it less valuable. It is also remarkable for its endurance when kept dry, but when exposed to damp or to wet it rapidly decays. The numerical value of its properties varies considerably, but in general terms it may be stated that, as compared with oak, good ash has frequently a still greater tenacity and likewise a greater degree of toughness, but, from its flexibility, especially when young, it has considerably less stiffness, which unfits it for many purposes.

Beech has frequently considerable strength, and is chiefly distinguished for its uniformity, its smoothness of surface, and closeness of grain. It likewise possesses no little beauty, and takes a good polish, more especially when its silver grain is skilfully exposed. When well seasoned and not too old, it is frequently used for the cogs of mill-gear-

ing, and is usually considered by millwrights as next to hornbeam, both in strength, toughness, and general suitability for that purpose. It requires, however, to be kept very dry, for in damp situations it quickly wears out, but, when beech is immersed in water constantly, its endurance is considerable. The strength of beech is nearly the same as that of oak; it is also tougher, but its stiffness is inferior to that of oak, even to the extent of 25 per cent.

Elm, although a cross-grained, rough wood, and mostly used for rough purposes, is yet held in great estimation for its toughness and non-liability to split by the driving of bolts. It is much used in the construction of blocks for pulley-tackle, for heavy naval gun-carriages, and for the naves of carriage-wheels. It is a wood which is little affected by constant immersion in water, but decays rapidly when alternately wet and dry, and consequently is not very durable for purposes involving exposure to a wet climate. Its chief defect in ordinary use is its great liability to warp, and twist, and get out of form; and, as regards strength, toughness, and rigidity, it is inferior to oak, as well as in almost every other respect.

The fir and pine woods are members of a large family, and are of great variety, and differ much in most of their properties. These classes of timber, in addition to being employed for building purposes, are likewise the chief materials that are used in great works, where the question of strength combined with cost becomes the most prominent consideration. The most durable varieties are the larch, the pitch-pine, and the firs, from Memel and Norway, and are valued mostly on account of the large quantity of resin, pitch, and turpentine, which they contain. The Canadian pine, variously termed white or yellow, is not a strong wood, but is much used by engineers for making patterns or models, on account of its smoothness of surface, its non-liability to warp, its comparative freedom from knots, and the facility with which it can be cut. The white or yellow pine is not nearly so strong or so stiff as oak, yet sometimes it is almost equal to it in its tenacity and toughness. In such a large family as that of the resinous firs and pines, there is almost an equal variation in their strength, toughness, and rigidity.

Hornbeam is a wood which is comparatively little used, except by engineers, for the teeth or cogs of wheels, and for mallets, for which purposes it is perhaps superior to all other woods, and this is mostly due to its great toughness and remarkably stringy coherence of fibre. Its cohesive strength and other properties depend much upon its age, as a plank, and still more on the age of the tree from which the plank was taken. When in the most favorable condition, it is fully equal to the average of oak (even when considered merely as a wood), but when cut from older trees, and when over-seasoned, it is frequently found worthless, and has soon to be renewed. When of proper age and quality, it has no equal for its own special purposes.

Mahogany is a beautiful, close-grained wood, but is used not so much on account of its strength, but more frequently because of its non-liability to shrink, warp, or twist, and from the peculiar property of taking a firm hold of glue. In the last respect it is superior to any other wood. Mahogany differs greatly in regard to its closeness, hardness, strength, and beauty. That from Honduras, called "bay-wood," is much inferior to that called "Spanish" mahogany, which comes from the West Indies; the former is much used in the construction of light textile machinery, but chiefly on account of its cheapness; and the latter is used for furniture or for other ornamental purposes. As regards strength, this wood is inferior to oak in all respects, and its great characteristic defect is unsuitability for exposure to the weather, or, indeed, for any purpose where it is made alternately wet and dry. When so subjected, it rapidly decays, and loses all its good qualities.

Oak, taken as a whole, is one of the strongest and most durable of woods, and is especially adapted for exposure to the weather of a damp climate, and is indeed suitable for almost every purpose where the properties of strength, stiffness, and toughness, combined with endurance, are required. Its value for ship-building is proverbial, and in its employment for the staves of casks, for treenails, for carriage-wheels, and for all such purposes requiring lightness and strength in combination, it is equally useful. From time immemorial it was esteemed the best timber for heavy roofs, and the condition in which some of these grand old roofs have reached our era fully attests the wisdom of the selection.

Oak is found of many degrees of quality, but probably none, taking every property into account, is superior to that which grows in England, and which is perhaps more durable than any other. Some of the foreign oaks are as good in some respects, but, as a whole, English is the best.

ON THE CAUSES OF CRIME.[1]

By Hon. HORATIO SEYMOUR.

THE name of this Association fails to give a full idea of its scope and aims. In terms they seem to be limited to that class of men who have brought themselves under the penalties of the law; but the moment we begin to study the character of criminals and the causes of crime we find that we are forced back to a scrutiny of our social system and of the weakness as well as the wickedness of our fellow-men. It is because the subjects of pauperism and crime thus lead to an analysis of human nature and to the consideration of social aspects

[1] Address before the National Prison Association at Baltimore.

that they have been made the matters of profound thought by able publicists and large-minded statesmen. At first thought it seems that the condition of a small body of men who have offended local laws should be left to the thoughtful control of local authorities, but it is soon found that the considerations involved are as broad as the spread of the human race. For these reasons leading men of different nations were drawn together at the late International Convention at London, and for these reasons this Association was formed. Crime knows no geographical limits, no boundaries of states. It is its nature to war with the welfare of the human family. It must be opposed by the united wisdom and virtue of all nationalities and of all forms of civilization. While local laws must frame penal codes, and local societies do the work of lifting up fallen men, still much is gained by a widespread sympathy and coöperation. There are many things which are beyond the reach of state action, in a moral point of view—things which do not come under the cognizance of laws, but which deeply affect the welfare of the whole country. At the first view our efforts seem to be limited to the justice which punishes crime, and to the charity which tries to reform the criminal, but we are soon led into a wider field of duty. We are apt to look upon the inmates of prisons as exceptional men, unlike the mass of our people. We feel that they are thorns in the side of the body politic which should be drawn out and put where they will do no more harm. We regard them as men who run counter to the currents of society, thus making disorder and mischief. These are errors. In truth they are men who run with the currents of society and who outrun them. They are men who in a great degree are moved and directed by the impulses around them. Their characters are formed by the civilization in which they move. They are in many respects the representative men of a country. It is a hard thing to draw an indictment against a criminal which is not in some respects an indictment of the community in which he has lived. An intelligent stranger who should visit the prisons of foreign countries, who should hear the histories of their inmates, would get a better idea of the inner workings of their civilization than could be gained by intercourse with a like number of their citizens moving in more conventional circles of society. As a rule, wrong-doing is the growth of influences pervading the social system, as pestilences are bred by malaria. Our study into this subject soon teaches us that prisons are moral hospitals where moral diseases are not only cared for, but science learns the moral laws of life—where it learns what endangers the general welfare of the community, what insidious, pestilential vapors permeate society, carrying moral disease and death into its homes. Prisoners are men like ourselves, and if we would learn the dangers which lurk in our pathways we must learn how they stumbled and fell. I do not doubt that some men are more prone to vice than others, but, after listening to thousands of prayers for pardon, I can

hardly recall a case where I do not feel that I might have fallen as my fellow-men have done if I had been subject to the same demoralizing influences, and pressed by the same temptations. I repeat here what I have said on other occasions—that, after a long experience with men in all conditions of life, after having felt, as most men, the harsh injustice springing from the strife and passion of the world, I have learned to think more kindly of the hearts of men, and to think less of their heads. If we find that crimes are in a large degree the hot-bed growth of social influences; if the weakness of human nature is always open to their attacks; if they may at any time enter into our homes and strike at our family—then we must at least guard against them as we do the pestilence. To protect the public health and to learn the laws of life, we build and sustain with liberal hand hospitals where the sick and wounded can be cured. The moral hospital should be regarded with an equal interest. In each of them we should seek to cure the inmates. In each of them we should seek to find out the secret cause of disease. With regard to both we should in a large-minded way feel that the laws of moral and physical life are a thousand times more important to the multitudes of the world at large than they are to the few inmates that languish in their gloomy walls. The public hold in high honor the man of science who treads the walks of the hospital to find out the facts which will enable him to ward off sickness and death from others. This Association appeals to the public for the same sympathy and support for those who labor to lift up their unhappy brethren from moral degradation, and at the same time to do the greater work of tracing out the springs and sources of crime, and of warning the public of its share of guilt in sowing the seeds of immorality by its tastes, maxims, and usages. We love to think that the inmates of cells are unlike ourselves. We should like to disown our common humanity with the downcast and depraved. We are apt to thank God we are not like other men; but, with closer study and deeper thought, we find they are ourselves under different circumstances, and the circumstances that made them what they are abound in our civilization, and may at any time make others fall who do not dream of danger. It is a mistake when we hold that criminals are merely perverse men, who are at war with social influences. On the other hand, they are the outgrowth of these influences. Crimes always take the hues and aspect of the country in which they are committed. They show not only guilty men but a guilty people. The world holds those nations to be debased where crime abounds. It does not merely say that the laws are defective and the judges corrupt, but charges the guilt home to the whole society. This is just, for most of the crimes which disgrace us could not be done if there were not an indifference to their causes on the part of the community. As certain plagues which sweep men into their graves cannot rage without foul air, so many crimes cannot prevail without wide-spread moral

malaria. It is the greed for gold, the love of luxury in the American people, which have caused the legislative frauds, the municipal corruptions, the violations of trust which excite alarm in our land. It is the admiration of wealth, no matter how gained, which incites and emboldens the desperate speculator in commercial centres to sport with the sacred interests of labor, to unsettle the business of honest industry, by playing tricks with the standards of value. Those who use the stocks of great corporations as machines for gambling schemes are more deliberately and artfully dishonest than the more humble swindler who throws his loaded dice. Many of the transactions of our capitalists are more hurtful to the welfare of our people than the acts of thieves and robbers. In the better days of American simplicity, honesty, and patriotism, these things could not have been done. No one would then dare to face a people indignant at such rapacious greed. Such influences have led to frauds, defalcations, breaches of trust. They have filled our prisons and overwhelmed many households with shame and sorrow. Yet the authors of such things are honored for their wealth, and we ask with eagerness how rich do they get, and not how do they get riches. To make the public feel that criminals are men of like passions with ourselves, and that crime is an infectious as well as a malignant disease, that its sources are not so much personal inclination as general demoralization, are the great first steps toward reform. When we feel the disease may enter our own houses and seize upon the mental and moral weakness of those we love, we are ready to study its causes and its workings. We shall then uphold and honor those men of humanity and true statesmanship who study out the cause of moral stains as we honor and support those men of science who search out in sick-rooms and hospitals the cause, and cure the complaint, which kills the body. He who masters the diagnosis of crime gains a key to the mysteries of our nature and to the secret sources of demoralization which opens to him a knowledge of the great principles of public and private reform —the true methods of a good administration of the laws. Pauperism and crime have been the subjects of earnest thought by the best and wisest men of the world, not only on account of their direct interest, but also on account of their relationship to all other matters of good government. Neither of them can be driven out of existence. They will always be problems to vex statesmanship, but they must always be battled with. In the social edifice they are like fires ever kindling in its different parts, which are to be kept under by watchfulness and care. If neglected, they burst out into the flames of anarchy and revolution, and sweep away forms of government. These subjects must be studied directly, and in their moral aspects. There is a pervading idea in our country, that the spread of knowledge will check crime. No one values learning more than I do; but it is no specific for immorality and vice. Without moral and religious training, it frequently becomes an aid to crime. Science, mechanical skill, a knowledge of business-

affairs—even the refinements and accomplishments of life—are used by offenders against law. Knowledge fights on both sides in the battle between right and wrong. At this age it lays siege to banks. It forces open vaults stronger than old castles. It forges and counterfeits. The most dangerous criminal is the educated, intellectual violator of the law, for he has all the resources of art at his command—the forces of mechanics, the subtlety of chemistry, the knowledge of men's ways and passions. Learning by itself only changes the aspect of immorality. Virtue is frequently found with the simple and uneducated, and vice with the educated. Surrounded by glittering objects within their reach, our servant-girls resist more temptations than any other class in society. We must look beyond the accidents of knowledge or ignorance if we wish to learn the springs of action. To check vice, there must be high moral standards in the public mind. The American mind must move upon a higher plane. To reform convicts, their hopes must be aroused and their better instincts worked upon. I never yet found a man so untamable that there was not something of good upon which to build a hope. I never yet found a man so good that he need not fear a fall. Through the warp and woof of the worst man's character there run some threads of gold. In the best there are base materials. It is this web of entwined good and evil in men's character which marks the problems and perplexities of the Legislature and judge, while there is no honest dealing with this subject unless the American people are charged with their share of guilt; and, while Christian charity leads us to take the kindest view we can of every man, it does not follow that crime should be dealt with in a feeble way. *Let the laws be swift, stern, and certain in their action.* What they say let them do, for CERTAINTY *more than severity carries a dread of punishment.* Let the way of bringing offenders to justice be direct, clear, and untrammelled. The technicalities of pleading, proof, and proceedings, in many of our States, are painfully absurd. To the minds of most men a criminal trial is a mysterious jumble. The public have no confidence that the worst criminal will be punished. The worst criminal cherishes at all times a hope of escape. In every part of our country there is a vague idea that certain men of legal skill can extricate offenders without regard to the merits of their case. This is a fruitful cause of crime. There is not in the minds of the American people a clear, distinct conception of our penal laws, their actions, and their results. Not less hurtful to justice are those fluctuations of the public mind, which shakes off spasmodically its customary indifference and fiercely demands a conviction of those who happen at such times to be charged with crime, and thus make popular clamor take the place of judicial calmness and impartiality. No one feels that there is in this country a clear, strong, even flow of administration of criminal law. The mood of the popular mind has too much to do with judicial proceedings. The evils connected with the administration of justice in

our land are due in a good degree to the swift changes in the material condition of our country. An increase of our numbers of more than 1,000,000 each year, of more than 2,500 each day, of more than 100 each hour, explains many of the causes of our overburdened system of penal laws. Framed for a different state of society, our perplexities are increased by the fact that more than one-quarter of this daily addition to our population is made up of those who come from other countries strangers to our customs and laws, and in many instances ignorant of our language. History gives no account of such a vast increase of the numbers of any country by constant peaceful action. Conquest rarely makes as many prisoners of war as we make captives to the peaceful advantages of our continent. They bring us wealth and power. They also bring us many problems to solve. British laws deal with British subjects. French courts decide upon the guilt or innocence of Frenchmen. Germany keeps by its usages and customs the ideas of right and wrong in the minds of the Teutonic race. But we in America have to deal with and act upon all nationalities, all phases of civilization. While these facts palliate the defects of our penal laws and their administration, they certainly make more clear and urgent the duty that we keep pace with the swift changes going on around us. More than this, it enables us to take the lead in the great work of reform as we deal with more plastic materials than are found in the fixed conditions of older nations. Here, too, we have a broader field filled with men of varied phases and aspects of different civilization, in which we can study the wants and the weaknesses, the virtues and the vices, of the human race. For a series of years nearly 300,000 immigrants are annually landed at the harbor of New York. Disorder and crime are always active along the line of march of great armies. I believe there is no instance in history of a movement of the human race so vast and long continued. I am glad to state a fact which in some degree palliates the disgrace which attaches to the administration of justice and the conduct of public affairs in that great city, but I should fall short of telling the truth if I did not also say that *the discredit of that great city mainly springs from the sad fact that its men of wealth as a body lack that genuine self-respect which leads to a faithful, high-minded performance of the duties each citizen owes to the public.* Is there any other basis upon which we can found this great work of patriotism and philanthropy than the one contemplated by this Association? It may at first view seem to be limited to a small class, but it opens up into a broad field of unpartisan, unsectarian labor. The objects we have in view, although they make our prisons their starting-point, are so wide in their bearing that they brought together at the London International Association, in the interests of our common humanity, men of the best minds of most countries of Europe and America. These, in spite of the differences of religion, language, and form of civilization, could act in accord in devising measures to lift up

the fallen and to spread the principles of morality and justice among the peoples of the world. It is found that true statesmanship, like true religion, begins with visiting the prisoners and helping the poor. It is certain that in our own country Edward Livingston, the public man who ranks high in European regard for intellectual ability, gained his position by his great work on the penal laws of Louisiana. When it was the fashion in the scientific world to hold that men and animals were dwarfed on this continent, this work was brought forward by our friends in Europe as a proof that statesmanship was full-grown here. It is a remarkable fact that an able foreign writer selected the Louisiana code and the proclamation of General Jackson against the doctrine of secession as the two ablest productions of the American mind, not knowing that they both came from the same pen. An exposition of Mr. Livingston's system has lately been published in France by M. Charles Lucas, a member of the Institute, and formerly president of the Council of Inspectors of the Penal Institutions of that country. M. Lucas is a distinguished writer and leader in the work of criminal reform. He belongs to that body of large-minded, philanthropic men, who seek to benefit humanity by wise systems of legislation. A certain breadth and reach of mind seem to mark those men who have entered upon the study of penal laws and the reformation of criminals. While there is much to condemn in our system of laws and in their administration, there is much to admire in the practical workings of many of our prisons. In some respects we are in advance of other people. Much has been done in many of our States to improve the condition of our criminals, and much more to rescue the young from vice and destruction. I should be glad to speak of the instances of ability and self-devotion shown by men who have charge of public or private charities established for the reformation of offenders. They would lend a weight to my argument which my reasoning cannot give, but I must leave these things to be brought out by the discussions of this congress. I only seek to show the ends at which it aims; I only seek to make for it the sympathy and support of the public in its efforts to combine and organize the forces of those who, in different parts of our country, are working in this field of philanthropic and patriotic labor. Crime has its origin in the passions which live in every breast, and the weakness which marks every character in its nature. It concerns each of us, as clearly as the common liability to fall prematurely before disease and death. No man can know human nature, no man can be a great teacher to his fellow-men, no man can frame laws wisely and well, who has not studied character in convict-life. There he can best see the lights and shadows of our natures, see in the strongest contrasts what is good and what is bad. The prisons, to which all vice tends, are the points from which the reform can be best urged which seeks to find out where vice begins. Starting from the sad ends of crime and running back along the tracks, it is seen that

in a large degree they are engendered by public tastes, habits, and demoralizations. It is in our prisons we can best learn the corrupting influences about us which lead the weak as well as the wicked astray, ay, and sometimes make the strong man fall into disgrace and misery. In these moral hospitals the thoughtful man, the philanthropist, and the statesman, will look for the causes of social danger and demoralization. When we begin at the prison and work up, we find opening before us all the sources of crime, all the problems of social order and disorder, all the great questions with which statesmanship, in dealing with the interests and welfare of a people, must cope when it seeks to lift up high standards of virtue and patriotism. In the most highly-civilized countries the subjects of pauperism and crime secure the most attention and thought. They turn men's minds from selfish to unselfish fields of labor. Those who enter those fields will find in them marks of toil and care by the best human intellects. The grandest minds have worked at their intricate problems. The ambition of the first Napoleon sought to gain immortality in his code of laws as well as in victories on the fields of battle. Much has been done in many of our States to improve prison discipline. Something has been done toward reforming prisoners, but the largest view of the subject, which looks to the moral health of society, and the baleful influences at work in its organization, have not received the attention they deserve. When prisons are visited by men of mind, when prisoners are looked upon with kindly eyes by those who can study their characters and learn from them the virtues, vice, and wickedness which mark our race; when, tracing back the courses of their lives, they shall find the secret sources of their errors and their crimes—then we shall have not only our laws justly enforced and reformed, wrong-doers punished, but, more and better than these, we shall gain a public virtue and intelligence which will secure the safety and happiness of our homes and the glory and stability of the republic. Then wealth gained by unworthy means will no longer be respected. No one can recall the events of the past few years, particularly those of the great commercial centres, without feeling there is an ebb-tide in American morals. Not a little of the glitter of our social and business life is a shining putrescence. Fungus men have shot up into financial prominence to whom a pervading deadening moral malaria is the very breath of life. They could not exist without this any more than certain poisonous plants can flourish without decaying vegetation. While I have tried to present in clear terms the claims of this Association upon the public sympathy and support, it must be understood that we claim for it only the merit of being a useful auxiliary to moral and religious teachings. If those who take part in its work should fall short of its broader and higher objects of a national character, they will at least get this great gain: they will learn to think more humbly of themselves, more kindly of their fellow-men, and to see more clearly the beauties of Christian charity.

THE RECENT PROGRESS OF NATURAL SCIENCE.

I.

ON the occasion of the celebration at Breslau of the twenty-fifth anniversary of Prof. Goeppert's presidency of the Silesian Society for National Culture, Prof. Ferdinand Cohn delivered an address, characterized by eloquence of the highest kind, on the above subject. As the wanderer, he said, who is climbing toward a high mountain-peak, feels from time to time the desire to stand still a little, and look back on the way over which he has passed, to enjoy the wider outlook which he gains from his higher stand-point, so, he thinks, there are moments in the uninterrupted progress of science, when we long in some measure to strike a balance, and see how much acquired property the present puts aside as useless, how much it uses only for temporary purposes, and how many enduring acquisitions have been made.

Dr. Cohn refers, no doubt with justice and some pardonable pride, to the foremost place held by Germany, during the last quarter of a century, in the march of science. At the same time he awards due praise to other European states, and above all to England, which, during that time and more particularly at present, he thinks, abounds in men of the highest eminence, whose scientific achievements stand prominently out on account of their astonishing energy, clearness, depth, and independence of thought. Still, we cannot but admit that Dr. Cohn is right in asserting that Germany is free from the dilettanteism which abounds in this country, and that as a rule science in Germany is both far more wide-spread and far more thorough than it is among ourselves, and that the opportunities furnished there to all classes for scientific study at the ordinary educational establishments have until recently left us almost nowhere. But, happily, signs of the beginning of the end of this state of things among us are becoming rife.

After briefly referring to the intellectual awakening of Germany along with the rest of Europe at the time of the Reformation, and showing how this start forward was, especially in the case of Germany, in a great measure frustrated by the Thirty Years' War, Dr. Cohn pays a high and justly-merited tribute to France, and especially to Paris, on account of the supreme place she took during the first thirty or forty years of the present century in nearly all the sciences. The glory of France in this direction has, however, he thinks, departed, and Germany is becoming daily more and more the intellectual centre of the world. Had Dr. Cohn written his lecture now, he might have somewhat modified his language; for, within the last few months, the signs have been many, that in the direction of science the French are determined to try to hold their own with the foremost in Europe. Their professors are prosecuting an amount of research which puts our

own to shame, while they are at the same time forming a school of investigators. We do not grudge to Germany all the praise she well deserves, and the influence which the results of German research exercise on other nations is likely to urge them to such vigorous and determined efforts, that, sooner or later, science and every other progressive influence shall be "great gainers." Meantime, however, Germany is doubtless in the ascendant.

In the year 1845 appeared the first volume, and in 1846 the second, of Humboldt's "Cosmos." As comprising a view of the whole created universe depicted with the most wonderful sympathy, the book is as it were a canon forming a key to every thing that was known of Nature at the time. No man was then more suited for such work than was in the highest degree A. von Humboldt. A "Divina Commedia" of science, the "Cosmos" embraced the whole universe in its two spheres, heaven and earth. Under the leadership of the great searcher of Nature, as Dante once by the hand of Virgil, we climb from the depths of the universe, with its farthest nebulæ and double stars, down through the star depths to which belongs our solar system, to the air- and sea-enveloped earth, where form, temperature, and magnetic condition, are unveiled to us; then to the wealth of organic life, which, stimulated by the light, unfolds itself on its surface. It is an overwhelming picture of Nature, of surpassing beauty of outline, abounding in grand perspective, with the most careful execution of the smallest detail.

But we cannot conceal from ourselves that the "Cosmos," published twenty-five years ago, is in many of its parts now antiquated, not merely because it is wanting in many facts which have since been discovered, but most particularly because Humboldt was ignorant of some highly-important questions which have since taken their place in the foreground of scientific discussion, while our scheme of the universe during the last ten years has been considerably modified by the introduction of new and influential ideas. Any one, who to-day would attempt to recast the "Cosmos," must proceed like the Italian architect who took the pillars and blocks of the broken temples of antiquity, added new ones, and rebuilt the whole after a new plan.

There are three discoveries which, during the last quarter of a century, have entirely changed the position of natural science: the mechanical equivalent of heat, spectrum analysis, and the Darwinian theories.

Since, in the year 1842, an unknown physician in a Swabian country-town, Dr. Mayer, of Heilbronn, pointed out that a hammer 424 kilogrammes in weight, which falls from the height of a metre on an anvil, raises the heat of the latter by one degree centigrade, and that by this process of bringing a falling motion to a stand-still it is converted into a fixed quantity of heat—since then has science gained a new conception of the conditions of matter and of the powers of Na-

ture. This new doctrine appears in the mechanical theory of heat announced by Joule, Krönig, Maxwell, and Clausius, in the doctrine of the conservation of energy of Helmholtz and Thomson, and by means of the brilliant writings of Tyndall it has become the common property of the educated world. Electricity and magnetism, heat and light, muscular energy and chemical attraction, motion, and mechanical work —all forces in the universe are only different forms of one and the same power, which has dwelt from the first in matter in invariable quantity, neither increased nor diminished; not the least trifle of it can be annihilated or created. Only the phenomenal forms of power are changeable; light can be converted into a chemical equivalent, this again into heat, heat into motion, and indeed a fixed quantity of one force always and only into an equivalent quantity of another. In like manner also the quantity of matter has remained unchanged from the beginning; not the least particle or molecule can be annihilated or created out of nothing, and only in the transformation of perishable bodies are the molecules formed into ever-new combinations. What we distinguish as natural forces are only movements of molecules, for the least particles of matter out of which bodies are composed are not inseparably united to each other, but are loosely held together and in continuous whirling and undulatory motion; according to the swiftness and width of undulation of the molecule will this motion of our nerves be regarded, now as sound, now as heat, then as light or as color. Moreover, the chemical union of the elements of matter, the attractive power of gravitation in all the bodies of the universe, are but varied forms of this universal motive force. The unity and permanency of substance with its two attributes, matter and force, and their innumerable modifications, which go to form the bodies of the universe, were in the first instance enunciated as a philosophical maxim by the great thinker Spinoza. Now it is established as a philosophic fact by means of exact measure and weight.

Again, on the inner organization of the system of the universe has unexampled light been thrown by the wonderful researches which were begun in 1859 by two men, united by the closest bonds of a friendship which bore rich fruit for science. After the light of the sun had, in the third decade of this century, been brought into the service of art by Niépce and Daguerre, Bunsen and Kirchhoff compelled it also to render service to chemistry and astronomy. Like those magicians of the legend who, through the power of their knowledge, compelled the spirits of the elements to disclose their most recondite secrets, the genius of these men compelled the rays of light imprisoned in the spectrum apparatus to make revelation of things in the world of stars which the curiosity of men had deemed forever inaccessible. Already had Kirchhoff ascertained what terrestrial elements were present in the sun's atmosphere, and what were not; quite recently has it been discovered that there is even present in the sun a substance

(*helium*) which hitherto has been unknown on the earth. Moreover, also, the inner structure of the sun, the distribution of its incandescent, liquid, and gaseous parts, its luminous and colored envelop, the nature of its spots and protuberances—all this is no longer a play-ground for fantastic imaginings, but the subject of exact research. Since the great eclipse of 1868, Lockyer and Janssen, Zöllner, Huggins, and Father Secchi, have observed, day after day, storms, whirlwinds, flame-sheaves, outbursts of burning hydrogen to the height of 20,000 miles: thus has been developed an entirely new science—the meteorology of the sun. Moreover, on other obscure regions of the heavens, on the physical and chemical conditions, even on the laws of the movements of the fixed and double stars, on nebulæ and milky ways, on planets and comets, on zodiacal and northern lights, has spectrum analysis thrown its enlightening rays. No less by rigorous mathematical method, through which astronomy, even at an earlier period, had been brought to a certain amount of perfection, has she in the most recent time enjoyed an unexpected triumph, by solving, through the researches of Schiaparelli, the riddle of the comets, in being able to recognize the identity of their nature with that of the swarms of shooting-stars whose remarkable brilliancy long ago made them universally known.

II.

During the last quarter of a century, the history of the formation of our earth has assumed a new aspect. When the "Cosmos" appeared, the opinion prevailed that our earth, once a globe of liquid fire, became covered with a crust of congealed scoriæ, on which, by-and-by, the first animal- and plant-life made its appearance. After an almost infinite length of time, during which the Silurian, Devonian, Carboniferous, and Permian strata were deposited, a terrible catastrophe, affecting simultaneously the whole earth, so completely destroyed the first palæozoic life, that not a single species survived the universal devastation. Upon the lifeless expanse, it was supposed, appeared then the Secondary Fauna and Flora, entirely unconnected with and different from the extinguished one, until, after frequent repetitions of the same process at longer or shorter intervals, man made his appearance, and along with him all existing plants and animals: with him begins the Historical Period, whose duration has not exceeded 6,000 years. The causes of these world-wide revolutions geology sought in the violent reaction of the molten interior against the once extremely slender crust.

In opposition to these views, the opinion peculiarly associated with the name of Lyell has made way, that no violent revolutions, returning at intervals, destroyed the external structure of the earth and all the life it sustained, but that all changes even in the earliest times affected only the earth's surface, and that these could only be the re-

sults of the same powers of Nature which are actively at work on the earth at the present time; and that, moreover, the gradual but ever active powers of water, of air, and of chemical change, have perhaps had a greater share in accomplishing these transformations than the fierce heat of subterranean masses of lava. The explorers of the buried remains of plants and animals show it to be impossible that all life in those geological formations could have been destroyed simultaneously, for many species are common at several stages; in particular, many existing animals and plants reach far back into the primitive world. Man himself could be shown to have been contemporary with many extinct species of plants and animals, and therefore his age on the earth must be extended back to an indefinite period. Man was witness to that inundation which buried the plains of the old and the new world under the waves of the sea of ice. Even in the immediately preceding period, when the sub-tropical elephant, rhinoceros, and hippopotamus, disported themselves in the lignite woods of Middle Europe, have traces of mankind been found. Only in the most recent times has a foundation been laid for the prehistoric records of mankind, by means of which we may be able to obtain a knowledge of the state of civilization, weapons, implements, and dwellings, of that primitive race.

No book of recent times, Dr. Cohn thinks, has influenced to such an extent the aspects of modern natural science, as Charles Darwin's work "On the Origin of Species," the first edition of which appeared in 1859. For, even to so late a period, was the immutability of species believed in; so long was it accepted as indubitable that all the characteristics which belong to any species of plants and animals were transmitted unaltered through all generations, and were under no circumstances changeable; so long did the appearance of new fauna and flora remain one of the impenetrable mysteries of science. He who would not believe that new species of animals and plants, from the yeast-fungus to the mammalia, had been crystallized parentless out of transformed materials, was shut up to the belief that in primeval time an omnipotent act of creation, or, as it may be otherwise expressed, a power of Nature, at present utterly unknown, interfered with the regular progress of the world's development; yea, according to the researches of D'Orbigny and Elie de Beaumont, twenty-seven different acts of creation must have followed each other previous to the appearance of man—but, after that, no more. It was Darwin who lifted natural science out of this dilemma, by advancing the doctrine that the animals and plants of the late geological eras no more appeared all at once upon the scene, than those of the preceding epochs simultaneously and suddenly disappeared; on the contrary, these are the direct descendants of former species, which gradually in the course of an exceedingly long period, through adaptation to altered conditions of life, through the struggle for existence, through natural and sexual selec-

tion, have been changed into the new species. Prof. Cohn does not doubt but that Darwin and his school may have over-estimated the reach of the explanations given by him to account for the transmutation of species, and especially the importance of natural and sexual selection, but the fundamental fact has been established, and will remain so for all future time. This fact is, that the collective life of the earth, from the beginning even until now, and from the fungus-cell up to man, represents a single series which has never once been broken, whose members through direct propagation have proceeded out of each other, and in the course of a vast period have been developed into manifold and, on the whole, perfect forms.

The sciences which are concerned with life have during late years been cultivated on all sides; even in earlier years Cuvier and Jussieu had done as much for zoology and botany as the state of discovery in their time permitted, but since 1858 the boundaries of both kingdoms have been widely extended by the labors of Carpenter, Huxley, and Pourtalès.

After referring to the researches of Goethe in the last century, and those of Bauer and of Johannes Müller in the present, in reference to the physiology of plants and animals, Prof. Cohn says it was only in our own time, and first in 1843 in Schleiden's "Grundzügen der Wissenschaftlichen Botanik," that the new principle was followed out; the principle, namely, that all vegetable phenomena and all the various forms of plants proceed from the life and the development of their cells. After Schwann discovered that animal bodies also were built up from an analogous cell, mainly by Virchow was then developed from this principle the modern cellular physiology and pathology which trace the condition both of healthy and diseased men and animals back to the life-function of their cells. But, as the lecturer says, to attempt to follow out the advances made by science in these directions during the last twenty-five years would require a large volume, and cannot be done in the space of a lecture or an article.

Even the cell itself has been changed. Until Schleiden's time it was a little bleb filled with fluid; we now regard it as a soft glutinous body constructed out of the albuminous protoplasm first distinguished by Mohl in 1845, and which is covered with a cellular integument, as the oyster is with its cell. After waxing eloquent over the cell as an entity, an "ego" by itself, and its relations to the outer world, Prof. Cohn says that science now teaches us that there is only one life and one cell, the cell of plants and of animals being essentially the same. The most highly-developed animal differs from the simplest plant only in the number and greater development of the matter composing the cells, but, above all, to the more complete elaboration (*Arbeitstheilung*), and the stricter subordination of the separate cells to the collective life of the organism. Between the two extremes of the living world, the yeast-fungus and man, there is the same difference as there is be-

tween a group of individual men who do not know how to organize their strength, and a strictly-disciplined, well-ordered army suitably formed and well armed, and which, by the strict subordination of the many wills to the central authority, is always equal to the highest achievements.

It is true that these scientific researches into biology have left as yet the most important questions unsolved. It is not yet possible to regard all life-processes as simple modifications of the other forces of Nature and to ascertain their mechanical equivalents; we cannot yet convert absolute heat or light into life; and, although chemistry is daily doing more and more to bridge over the gaping chasm which once separated the organic and inorganic systems, it has not yet succeeded in finding out the precise matter which exclusively supports the life-process, on which alone the cells subsist. Thus, then, the beginning of life is still wrapped in obscurity.

After referring in this connection to the transmission of epidemics among plants, animals, and man, and to the microscopical labors of Leeuwenhoek, Ehrenberg, Gagniard-Latour, Schwann, and Kützing, Prof. Cohn goes on to say that the investigators of the present time, to whom Pasteur has given a powerful impulse, have been the first to establish beyond doubt that without *Bacteria* no putrefaction, and without yeast-fungi no fermentation takes place; that this decomposition is accomplished only through the sustenance and living activity of those microscopic cells.

Many a mystery of life will doubtless be unfolded to us if our opticians during the next twenty-five years should manage to raise the power of the microscope in the same proportion as in the previous quarter of a century, in which it has been at least quadrupled. The best microscope of Schiek and Plössl in 1846 did not magnify more than 500 diameters; the "immersion-lens xv." of Hartnack over 2,000 diameters. Still Dr. Cohn does not venture to hope that during the next twenty-five years all the questions of science which are at present being agitated will be solved. As one veil after another is lifted, we find ourselves behind a still thicker one, which conceals from our longing eyes the mysterious goddess of whom we are in search.

Dr. Cohn, in concluding his eloquent address, attempts to point out the characteristics which distinguish the present from the past generation. In the former epoch, students confined their researches to single and carefully-marked-off divisions of Nature, without any regard to the neighboring and closely-allied regions, which must necessarily lead to the one-sided view that these divisions belong to Nature herself. In the present generation, on the other hand, the several physical sciences have entered into the closest organic union. Physics and chemistry, along with mathematical astronomy and geology, have been blended into a new science—the history of the development of worlds; palæontology, systematic botany, and zoology, have been joined into a

united science of organisms; the physiology of plants and of animals have become coalesced in universal biology; the boundary between the organic and inorganic aspects of Nature is being ever more and more obliterated, and out of the several natural sciences a single uniform, universal natural science is being constructed.

But the deeper natural science penetrates from outward phenomena to universal laws, the more she lays aside her former fear to test the latest fundamental questions of being and becoming (*Sein und Werden*), of space and time, of matter and force, of life and spirit, by the scale of the inductive method, and the more confidently she lifts her views concerning the universe out of the cloudy atmosphere of hypothesis into the clear ether of theory grounded on fact, so much the more will the gap be narrowed which since Kant has separated science from philosophy. Schiller's advice to philosophers and men of science—

"Feindschaft sei zwischen euch; noch ist das Bündniss zu frühe;
Nur wenn in Kampf ihr euch trennt, dann wird die Wahrheit enthüllt,"

has been followed for more than half a century, to the gain of the natural sciences, but often to the injury of philosophy, which would knock away the firm ground from under our feet. But since Herbart and Schopenhauer, and especially through Hartmann's labors, have the two chief drifts of the work of the human mind been approaching; and if natural science has a mission to mould the future of our race, she must court the purifying influence of philosophical criticism; and this mission, in Dr. Cohn's estimation, the science of the future cannot reject. Its importance rests not merely in the much interesting and useful information which can be made available to trade and industry, for daily economy and universal civilization; she must build a sure foundation for our collective view of the universe, for our knowledge of ultimate and highest things. It must be no longer the case that even our most educated classes, in consequence of insufficient education, have neither interest nor intelligence for the pursuit and acquisition of scientific knowledge. Moreover, science will be no more able to shun battle with other systems of the universe which have been hallowed by the traditions of a thousand years, than were Socrates and Aristotle, Copernicus and Galileo. Victory will lie on the side of truth.

But if anxious souls should fear that, with the advance of a scientific knowledge of the universe among the people, would come a breaking up of political and social order, let them be assured by the teaching of history. When we perceive the flash of an electric spark, we certainly do not take it for a bolt darted by the revengeful Jupiter; and, as the vault of heaven is resolved into air and light, so also must the Olympus be shattered which was built thereon. But the ideas of the true, the beautiful, and the good, remain unshaken; they have been all the more firmly established, for they have been deduced from the order

of the universe and from the mind of man himself. And that the pursuit of natural science does not lead to materialism, and in no way injures the ideal mind, is vouched for by the case of Alexander von Humboldt himself, who, even in extreme old age, kept up his love for research and power of work as well as his lively susceptibility for and energetic share in all the noble pursuits of mankind.

Dr. Cohn concludes his lecture, so brimful of true eloquence founded on sober fact, with a high compliment to the many worthy qualities of the president of the Silesian Society, Dr. Goeppert. Such a man as he is said to be, the lecturer truly says, may hope, like Goethe, Humboldt, and other previous philosophers, to maintain, to the utmost limit of existence, life, heart, and spirit, full of the freshness of youth, and, moreover, in later generations be honored as a true guardian of the highest good of grateful mankind.—*Nature.*

EPILEPTIC ORIGIN OF ISLAMISM.

DR. J. C. HOWDEN, medical superintendent of the Montrose Royal Lunatic Asylum, recently read an able paper before the Edinburgh Medico-Psychological Association on the mental condition of epileptics in relation to the religious sentiment. He states that these patients manifest the strangest mental contradictions. Irritability, suspicion, impulsive violence, egotism, and strong homicidal propensities, are among the most commonly-observed characteristics in the insane epileptic; but these traits are very frequently combined with strong devotional feeling, manifested in simple piety or in decided religious delusions. Dr. Howden has the following remarks on the peculiar mental characteristics of epileptics:

"The mysterious nature of the disease—the consciousness of infirmity and helplessness—develops a craving for sympathy in the epileptic which we rarely see in other lunatics. In the wards and airing-courts of our asylums, epileptics may be distinguished from their fellow-patients by the fact that they are generally found associating in little groups of twos or threes. They sympathize with each other, lean on each other for help in the time of trouble, and, however much they exhibit violence and viciousness to others, they rarely attack each other. Along with this desire for sympathy, the epileptic is mercifully endowed with strong hope. He is always getting over his trouble, he thinks the turns are less severe, and will tell you, perhaps the day before a fatal seizure, that he thinks he will have no more fits. We all know how much hope has helped the physician in his efforts to combat this disease with a whole battery of drugs, each of which in its turn seems for a time to promise success, only too surely to fail in the end. This

craving for sympathy finds a deep response in the highest development of hope—religion; and the sufferings of this life are assuaged by the assurance of sympathy and aid from Heaven, and of a blessed future where suffering and sorrow are no more.

"Again, when religious emotion develops itself in delusions, another element of character comes into play. Vanity and egotism give shape and form to his dreams and fancies. When cut off by sleep or epileptic trance from communication with the outer world through the senses, the ever-waking mind operates on the stores which memory has hoarded, and works up those wonderful visions in which the most exaggerated egotism finds gratification in interviews with the Almighty, direct communications with the Saviour, or revelations as to the salvation of the human race."

Several remarkable instances are related in which devout feeling, offering the strongest evidences of genuineness, coexisted with the most dangerous forms of homicidal violence. A young man, aged twenty-seven, subject to irregular epileptic fits, read his Bible attentively, and showed a strongly devotional frame of mind. While in the asylum, he wrote a very earnest letter to the clergyman of the village church, asking to be permitted to partake of the sacrament, and was allowed to do so; "yet a few weeks afterward he nearly killed a fellow-patient—a poor, demented creature—because he called him a Fenian, and his conduct continues to this day a singular jumble of piety and vice.

"When actual religious delusions are present in epileptics, these are generally founded on visions occurring during a state of trance, but sometimes, as in the following case, the delusion continues after the memory of the vision on which it was founded has faded. The case is curious, not only from the nature of the delusions, but from the fact that the subject of them was a boy only thirteen years old, an epileptic from infancy. On admission to the asylum he spoke with an earnestness, and, granting his premises, an intelligence beyond his years. He told me he was Adam, the first man, born again into the world. When questioned as to his previous life in the Garden of Eden, he replied that he had been so long dead that he could not be expected to recall particulars, but added that it was perfectly true that he had eaten the forbidden fruit, and when asked why he had done so, he replied: 'It's all very well to blame me; but you would just have done the same thing if you had been in my place.' He pointed to a picture of a woman on the wall, which he said was the portrait of Eve. He says he has been in heaven, and describes what he saw there. He takes fits every two or three weeks, and on recovering from them he is dull and stupid; then he becomes possessed of some extravagant delusions, always of a religious nature. Sometimes he returns to his old delusion that he is Adam, sometimes he is God, at other times Christ, and not unfrequently the devil. When ques-

tioned as to the ground of his belief, he generally says that it has been revealed to him, and that he feels that it is true, pointing with his finger to his epigastrium."

After describing a variety of cases of trances, visions, and religious delusions, occurring in the epileptic, Dr. Howden remarks that these and like cases naturally suggest the inquiry as to how far epilepsy has had to do with the origin of certain religious creeds, and how far the visions of the many so-called religious impostors may have had an epileptic origin.

"There is evidence that many religious fanatics were epileptics or cataleptics. Hecker, describing the dancing mania of the fourteenth century, says: 'While dancing, they neither saw nor heard, being insensible to external impressions through the senses, but were haunted by visions, their fancies conjuring up spirits, whose names they shrieked out. . . . Others, during the paroxysm, saw the heavens open, and the Saviour enthroned with the Virgin Mary, according as the religious notions of the age were strangely and variously reflected in their imaginations. Where the disease was completely developed, the attack commenced with epileptic convulsions. Those affected fell to the ground senseless, panting and laboring for breath. They foamed at the mouth, and, suddenly springing up, began their dance amid strange contortions.'

"Ann Lee, the mother of the Shakers, is described as 'a wild creature from birth, a prey to hysteria and convulsions, violent in her conduct, ambitious of notice, and devoured by the lust of power.' While in the prison at Manchester a light shone upon her, and the Lord Jesus stood before her in the cell, and became one with her in form and spirit. A writer says: 'A combination of bodily disease—perhaps catalepsy—and religious excitement appears to have produced in her the most distressing consequences. During the spasms and convulsions into which she occasionally was thrown, her person was dreadfully distorted, and she would clinch her hands until the blood oozed through the pores of her skin. She continued so long in these fits that her flesh and strength wasted away, and she required to be fed, and was nursed like an infant.'"

There is strong evidence that Mohammed was an epileptic, and that, though a man of undoubted power and strong religious feeling, he founded his pretensions as a medium of revelation on visions which appeared to him during epileptic trances. Washington Irving, in his "Life of Mohammed," says:

"Dr. Gustav Weil, in a note to 'Mahommed der Prophet,' discusses the question of Mohammed's being subject to attacks of epilepsy, which has generally been represented as a slander of his enemies and of Christian writers. It appears, however, to have been asserted by some of the oldest Moslem biographers, and given on the authority of persons about him. He would be seized, they said, with violent

trembling, followed by a kind of swoon, or rather convulsion, during which perspiration would stream from his forehead in the coldest weather; he would lie with his eyes closed, foaming at the mouth, and bellowing like a young camel. Ayesha, one of his wives, and Zeid, one of his disciples, are among the persons cited as testifying to that effect. They considered him at such times as under the influence of a revelation. He had such attacks, however, in Mecca, before the Koran was revealed to him. Cadijah feared that he was possessed by evil spirits, and would have called in the aid of a conjurer to exorcise them, but he forbade her. He did not like that any one should see him during these paroxysms. His visions, however, were not always preceded by such attacks. Hareth Ibn Haschem, it is said, once asked him in what manner the revelations were made. 'Often,' replied he, 'the angel appears to me in a human form and speaks to me. Sometimes I hear sounds like the tinkling of a bell, but see nothing.' (A ringing in the ears is a symptom of epilepsy.) 'When the invisible angel has departed, I am possessed of what he has revealed.' Some of the revelations he professed to receive direct from God, others in dreams; for the dreams of prophets, he used to say, are revelations."

Bayle says ("Dictionnaire Historique et Critique," article "Mohammed") that he was subject to the *mal caduc* (epilepsy), and that he tried to make his wife Cadijah believe that "he only fell into convulsions because he could not sustain the glory of the appearance of the angel" Gabriel, who came to announce many things from God concerning religion.

The following passage is quoted by Moreau (de Tours) from "Gisbert Voctins:"

"Non video cur hoc negandum sit (epilepsiæ et maniacis deliriis aut enthusiasmis diabolicis Mahommedi ad fuisse energema) si vitam et actiones ejus intueamur."—"I do not see how it can be denied (that the fanaticism of Mohammed arose from the maniacal delirium or diabolic enthusiasm of epilepsy), if we look carefully into his life and actions."[1] The inhabitants of Mecca considered him to be a madman and possessed, and his wife thought he was a fanatic deceived by the artifices of a demon.

"By his ecstatic visions" (says Moreau), "had he not become the dupe of his visions, whence sprung the first idea of his divine mission, and then had not these visions become the principal, if not the sole basis of his apostolic works, as well as the source of his audacity, and of his prophetic power over the ignorant and superstitious spirit of his countrymen?"[2]

It seems incredible that a religion which sways the minds of 200,000,000 of the human race at the present day should have no better foundation than the visions and dreams of an epileptic.

[1] "Life of Mohammed," by Washington Irving, p. 30.

[2] "Psychologie Morbide," par le Dr. J. Moreau (de Tours), p. 552.

Religious systems must not, however, be judged of by the ordinary laws of reason; they must be estimated rather by their influence for good or evil on men's lives and on society.

The imagination may, when unfettered, during a state of trance, work upon what was during consciousness a constant theme of reflection, and elaborate therefrom ideas and theories pregnant with many moral truths, and, though vanity has, no doubt, influenced the actions of most of the so-called religious impostors, it has taken the direction of attempts to benefit their fellow-men, and to satisfy that craving which seems instinctive in the human mind to lean for aid and sympathy on something stronger and better than itself, to connect the present life with an eternal state of existence, and to attain a high standard of moral perfection.

Imperfect though the doctrines of such men as Swedenborg and Mohammed may be, they attempted to satisfy, and to a certain extent have succeeded in satisfying, those yearnings in many human beings, whom they have made, if not better, at least more contented with life than if left to the unbridled guidance of their own passions and impulses.

A millennium of reason may be in store for the human race, but the day is yet far distant; and we cannot afford at present to sneer at the credulity of our fellow-men, when in the latter half of the nineteenth century we hear of a learned bishop consecrating a cave where Bernadotte Soubarons, a girl of fourteen, saw the Virgin Mary, and read of thousands of pilgrims flocking to this sacred grotto in the year 1872 to worship with the most earnest convictions.

Need we wonder that the ignorant Arabs, 1,300 years ago, living, as far as a knowledge of Nature's laws was concerned, in a state of heathen darkness, should have been attracted to the Moslem faith, which, while it held out bright hopes for a future life, consorted well with their inclinations in the present.

The mere act of believing is, to most men, a source of happiness, and the happiness appears sometimes to be in the inverse ratio to the credibility of the thing believed in, as Moreau (de Tours) says: "Ils croient, mais pour croire, en tout état de cause, ils faut d'abord qu'ils ne comprennent pas."—*Abstract from the Journal of Mental Science.*

ASPHALT PAVEMENTS.

WITHIN the past few years several streets in the city of New York have been overlaid with a compound called by its inventors "asphalt," but better characterized by the public as "poultice pavement." When first laid down, this material appeared to fulfil all the requirements of a serviceable pavement, being smooth, hard, and apparently durable. Actual experience, however, showed the material

to be so friable that in a short time the ordinary travel on the streets reduced it to a fine, black powder, which, in dry weather, was thrown up in murky clouds by every passing vehicle and every gust of wind, finding entry into the adjacent houses through the minutest crevices, and in wet weather was kneaded into a nasty, viscous mud. Soon the streets thus paved were impassable, and the commissioners were forced to order the removal of what was left of the "poultice" pavement.

This experience was not well calculated to conciliate public opinion in favor of asphalt as a material for paving; and, though travellers returning home from Paris were loud in praise of the asphalted roadways of that capital, contrasting the roar of our granite-paved, filthy thoroughfares, with the smooth, noiseless, cleanly streets of the French capital, they were listened to with incredulity. Their "odious comparisons," instead of causing us to envy the Parisians for their happy solution of the great question of pavements, had only the effect of exciting compassion for the poor outside barbarians who put their trust in asphalt. For, had we not tried asphalt here, and found it wanting?

Yet it was not the asphalt pavement at all which proved a failure in these experiments. The material used was a spurious compound; a mixture of sand and gas-house refuse, which had this only in common with asphalt, that the two substances went by the same name. Here the adage, "Give a dog a bad name," was reversed. The genuine asphalt pavement was thus involved in the ill-fortune of its base counterfeit; only for a little while, it is to be hoped. So soon as we discover within convenient distance from our centres of population native deposits of asphalt, we shall avail ourselves of the improvements introduced into the art of road-making in France, and the "coming man" can go about his affairs without having his ears stunned by the clatter and roar of vehicles; the horse of the future perform his service without constantly risking life and limb; and the carriage of the future roll along without being jolted to pieces. In France the asphalt pavement is as much a success as the railway, and, as we are still seekers, still experimenters in this matter, it is perhaps well that we learn the processes followed by French engineers.

Dr. L. Meyn, of Halle, has published a pamphlet on "The Asphalts," which sums up all the information that is accessible regarding this material. In the present paper we propose to give, mostly in his own words, the history of asphalt as a material for paving foot-paths and roadways.

Natural asphalt, or asphalt-stone, is a porous, calcareous rock, saturated with bitumen, or natural tar, and capable of being worked into a tough, hard mastic. It is not unlike mortar in general appearance, and its color is usually chocolate, giving a fracture of lighter color. Its grain is fine, and each molecule of limestone is coated with the bitumen. The proportion of the latter in the mass varies from 7 to 15 per cent. At a temperature of between 338° and 356° Fahr., asphalt-

stone falls to powder, and may then be dissolved in hot melted bitumen.

This substance does not occur very abundantly in Nature, the only deposits of any importance, so far as yet known, being found in the Val de Travers and at Seyssel, in Switzerland; Seefeld, in the Tyrol; Lobsan, in Alsace; Hölle, in Holstein; and Limmer, in Hanover. The deposit at Hölle is by far the most extensive in Europe; but, though here the particles of the limestone are thoroughly permeated by the bitumen, the material is not considered by the Paris Asphalt Company to be suitable for pavements, because it contains an excess of pure petroleum. Yet Dr. Meyn thinks that by exposure to air the greater part of this surplus may be dissipated, and the remainder oxidized.

Ancient authors state that Babylon was partly built with asphalt, and that an asphalt cement was used for the walls of Nineveh. A Greek physician, Eirinus, endeavored to bring this substance into use as a building material in 1712. He was the first to discover a method of reducing the asphalt of the Val de Travers to the liquid state, and obtained the monopoly from the King of Prussia of all the asphalt beds he might discover in the principality of Neufchâtel. He published in 1721 a "Dissertation on Asphalt," in which he gives as follows the process of making asphalt cement: "The preparation of this cement is very easy. The stone must be slightly warmed till it can be coarsely powdered. A small quantity of pitch is added, to make it thinner and more soluble, and then the whole is melted over a slow charcoal-fire." This cement was to be used instead of mortar, and also to protect wood and stone-work against decay. There is still to be seen at Couvet, a little village in the Val de Travers, a flight of stone steps, dating from the time of Eirinus; the lower steps are coated with asphalt, and are almost entirely unimpaired, while the upper ones, which were not so protected, are worn into holes. But the material did not continue long in use for building purposes, for in 1802, after the discovery of asphalt-stone at Seyssel, near Geneva, we find the preparation of a mastic, from bituminous limestone and tar, heralded as a new invention.

In 1832, the Seyssel quarries fell into new hands, and from that period we date the progress made in the matter of asphalt pavements. The new proprietor of the quarries, Count Sassenay, devoted himself exclusively to producing a continuous and homogeneous material, and carefully instructed his workmen in the best manner of laying this pavement. The celebrated foot-path of the Pont Royal, the fine pavement of the Place de la Concorde, Paris, as well as many pavements at Lyons, belong to that period. Sassenay's process is still employed in preparing asphalt for paving foot-paths, and the mode of laying down the pavement is as follows: The foundation must be even, for any inequality of its surface will cause the pavement to wear out more rapidly in some parts than in others. The mastic is broken into

pieces, and melted in caldrons with bitumen at a temperature between 150° and 170° Cent. Then from 60 to 70 per cent. of sand is added, and the mixture is ready for application to the surface to be covered.

But still a good pavement for roadways was a desideratum. First the experiment was tried of laying down a bed of broken freestone, and pouring over this melted asphalt mastic. This method, however, proved unsuccessful, for, when cold, the mastic was too brittle, and if one of the corners of the stones was struck and broken by carriage-wheels, a hole was made, which gradually widened, and was difficult to mend. In Lyons, a layer of asphalt mastic, two inches in thickness, was spread over four inches of concrete. This was found to be an excellent pavement, but a fatal objection to it was its costliness.

It was at last observed that the roads and paths leading to the quarries of the Val de Travers were always in good condition, firm, solid, and elastic. Here was an asphalt pavement, formed of the small pieces of the mineral which fell from the carts, and which were pressed down and flattened by the wheels. The first highway asphalted on this principle was that between Bordeaux and Rouen. The road was first macadamized, and then covered to the depth of an inch and a half with asphalt, broken up in small pieces. As the plan appeared to be a complete success at first, several other roads were asphalted in the same way. Soon, however, the crushed granite of the macadam began to cut its way through the asphalt, and broke its continuity, thus allowing it to be permeated with dirt and water. Finally the problem was solved by a Swiss engineer, A. Merian, of Basle, who proposed to lay down powdered asphalt in a warmed state on the street, and, by applying strong pressure, to form at once an impermeable, elastic surface. The French engineers readily adopted the suggestion, and the first trial of the new method was made in the Rue Bergère. The engineers cried "Eureka!" and well they might, for experience in Paris shows that—1. The asphalt costs, in the first instance, one-third less than stone pavement; and 2. That the annual cost of maintenance is three-quarters less than that of a macadamized road.

The process of preparing the asphalt pavement is thus described by M. Léon Malo: The asphalt-stone is brought direct from the quarries, and broken up into small pieces, about the size of those used for macadamized roads; it is then heated over a stove in a drum-shaped iron vessel with feet, till it crumbles into powder. In order that the powder may not lose its heat, the whole apparatus is conveyed on to the street where it is to be applied. Then a foundation of *béton* is laid, about four inches deep, which may, however, be thicker or thinner, according to the nature of the soil. On a macadamized road the concrete may be omitted; but on loose soil it should be laid as thick as six inches. The arch of the roadway should only be just sufficient

to drain off the rain-water. The powdered asphalt is then spread over the surface, to a depth of 16 to 20 inches (according to the amount of traffic), and stamped down. Then a heavy roller is drawn over it.

With regard to the danger of horses slipping and falling on the smooth surface of the asphalt pavement, the following facts are of interest:

At Lyons, which has long had mastic roads, a number of cavalry-horses fell on a street of compressed asphalt. This accident arose from the circumstance that the asphalt had been laid on an old macadamized road, and had therefore that considerable arch which is unnecessary and dangerous for the asphalt road. The cavalry riding in a long line, those horses near the side of the road slipped on the steep incline.

At Marseilles, where the asphalt roads from the harbor to the town were made with a very gentle curve, there has been no increase in the number of accidents, though the traffic is enormous. A very slight arch of the road is quite sufficient to allow the rain to run off from such a smooth surface.

It is also not advisable to lay the asphalt on any street with a gradient greater than 1 in 60, though in London some streets having a gradient of 1 in 57, and even to 1 in 46, have been covered with asphalt without any apparent danger. It is of course extremely difficult to get any accurate information about the number of accidents on the streets, general vague impressions being worthless; but in Paris the number of horses which were observed to fall in the Rue Neuve des Capucines, during two months, was as follows: In the former, which was paved with sandstone, in blocks, from Fontainebleau, one horse in 1,308 fell; on the latter, which was covered with asphalt, one in 1,409, so that the balance was in favor of the asphalt.

In snow or frost asphalt is not so slippery as granite, being in itself warmer, and also more easily warmed by the slightest rays of the sun; hence, the ice is more slow in forming, and quicker in melting, than on granite.

It has been proved that the greatest number of accidents to horses happen when the asphalt is not cleaned, for the surface is never muddy or greasy, except with foreign matter, and this ought to be constantly washed off with water, which is plentifully laid on in Paris, and to some degree in London. At any points where this cannot be done, a slight sprinkling of coarse sand will prevent the horses slipping. This is only a temporary remedy, but valuable in case of emergency. It is one of the great advantages of asphalt, however, that it is so easily and cheaply cleaned.

In case of a conflagration, the asphalt pavement will not help to spread it. In London heaps of wood were set fire to on asphalt pavements, but, when the embers were raked away, there were only a few weak flames seen issuing from the asphalt, and they went out of their own accord in a few moments.

In conclusion, we give the results of experience with these pavements in London, and these are: 1. The first cost of the asphalt road is the same as that of a granite pavement. 2. The annual cost of maintenance is a trifle less. 3. Where a granite pavement is worn out in from seven to ten years, an asphalt pavement is still in perfect condition. 4. Asphalt, when taken up, may be used again and again.

REGARDING MATTERS IN INDIA.

By CAPTAIN LYON.

A LECTURE BEFORE THE LONDON SOCIETY OF ARTS.

IN describing the various views, the lecturer said: I beg to ask your assistance this evening in what I am going to do. I want you to use your imagination, and fancy yourselves on board ship, and —so that it may be pleasant and agreeable—in one of these new Bessemer ships, where you have no sea-sickness to endure. We will go down the Mediterranean, through the Suez Canal, down the Red Sea—where the heat is frightful, and the thermometer 120° on deck and any number below, in fact perfectly suffocating—to Aden. We will not stay there, but press on to Ceylon, where we shall arrive in ten days, and where the beauty of tropical vegetation is seen for the first time—lovely beyond description. Thence we go on to Madras; but before we arrive I will show you the god Ganesa. There he is, in all his glory. He is the god most worshipped of all the Hindoo gods —a beauty, you see. His history is as follows: For certain reasons it was considered necessary that Siva should marry, and as he was an old bachelor he did not like it. However, the marriage took place between him and Parvatee, who unfortunately gave birth to a son. Parvatee had a brother, called Vishnu, who was always upbraiding her, and Ganesa, who was a most lovely child, always took his mother's part. At last, Vishnu one day began upbraiding her again, and Ganesa threatened to thrash him, and the result was that they had a fight, and Ganesa got a tremendous thrashing instead, and Vishnu, with one blow of his cimeter, cut off his head. Parvatee took a fit of the sulks at this; but in the end Siva was asked to restore Ganesa to life. Siva at last consented to do so; but on looking for him they could only find his body, but no head. Here was a difficulty. The gods were consulted as to what was to be done, and the result was that a god was sent to bring the head of the first animal he saw and put it on Ganesa's body; and this animal, unfortunately, was an old elephant, with one tooth. They took his head and stuck it on to Ganesa's body, and you see the result. Parvatee did not like this, and in return, to

pacify her, Brahma said that Ganesa should be most worshipped of all the gods. Before a Hindoo builds a temple, or a house, or goes a journey, he prays to Ganesa. And so I say: "O Ganesa—glorious and honorable Ganesa—grant me success this evening. May I please all this people! All reverence to you, Ganesa."

I will now go back to our steamer, and we must fancy ourselves coming into Madras. There is the steamer just as she appears soon after daylight off the roads. Madras has no harbor whatever, and so every captain arrives as early as possible, to get away before night; as soon after daylight as he can he casts anchor in the roads, and if you come on deck in the morning you will see round the vessel the boats in which you will be expected to land, one of which you are now looking at. I leave you to imagine the effect when an English lady sees for the first time twenty or thirty of these fellows in the morning. The boat is called a catamaran, and it is the only chance you have of landing if the surf is high. You are lashed to this thing, and they bring you to shore. The sea washes right over you, but, as the water is warm, except that you do not like the ducking, it does not much hurt you. These fellows are off the boat, and in the water, and on to the boat again in a moment. Although they say the sea abounds in sharks, they are never eaten, and they actually say the sharks will not touch a black man.

Well, the first thing you do, having landed, is to go to an hotel, and find yourself a carriage. There are three kinds you can choose from. There is the old palanquin, put upon wheels, called the palanquin coach, which is what Europeans generally use. The horse looks sorry, but he can go; every horse has his *ghora-walla* to attend him, and a woman too. You buy the ghora-walla and the woman when you buy the horse. It is the man's business to clean and feed the horse, and the woman's to cut grass for him. The next carriage is called a *shigrampoo*. You pay 1*s.* 6*d.* an hour for this, and have to pay beforehand, and whether the pony goes or not it is all the same. The Hindoo has no idea of time; he prefers that the pony should not go, and so Europeans seldom use this. The next is a bullock bandy—no springs. The bullocks come from Mysore, and are admirable goers. The native standing by the side is the owner, and the other is the fellow that drives. The natives are all vain, and want to be photographed, and are sure to stand wherever they see a camera. Now we start on our way to the hotel, having chosen one of the conveyances. We shall not have gone far before we see something of this sort at the corner of nearly every street—an almost naked barber, engaged in the act of shaving, all for one penny. They say they are most wonderful fellows at it. They actually shave people while they are asleep. I found them very indifferent hands. If they are not engaged in that, these very fellows are shaving the natives' heads. It is wonderful to relate that, although there is the most intense heat, the natives invari-

ably shave their hair off. They say it cools them. You never hear of a sunstroke.

We will now turn into the main street of Madras. The large building to the left is a sort of emporium, where every thing is sold. The building on the right is the Bank of Madras. Passing through this, at the end we come to the bazaar, and we will just pass through a corner of it and see one or two of the shops, such as everybody is obliged to use if he is not prepared to go to one of the few Europeans in the place. There you see the cap used by the natives as a substitute for a hat—it is nothing but a piece of linen folded in a peculiar shape. You see the two men who are making these caps are wearing similar ones. Another shop is that of a native tailor. The natives themselves never wear much that requires any shaping, and consequently there is little for them to do in the way of cutting out. But they are wonderfully good hands, nevertheless.

Having passed these, we soon get to the hotel, hoping to find peace and rest. But when the Peninsular and Oriental steamers come in everybody knows it, and hundreds of the natives are on the lookout to get money. They see what hotel you go to, and then begins the cry for *bakshish*—nothing but bakshish. But first of all let us look at the *picota*, the machine that is used for drawing water. There it is, and the natives run along the top of the long pole to press it down, and then they turn round and run backward and foreward, keeping the machine at work all day; and in the rice-season it is very disagreeable, and even perfect purgatory, to live near where one of these machines is, and hear the two bits of wood rubbing together, and going on "cah, cah" all night and all day. It drives you almost mad. Woe betide the unhappy fellow who gets a bed near one of these picotas.

Arrived at the hotel, you find a lot of fellows asking for bakshish, and playing drums. You give them some money, only too glad to be rid of them. They are succeeded by fellows who play tricks with some stuff dipped in turpentine, through which a man jumps backward and forward. When they are gone, they are succeeded by a conjurer who shows you the way to get rid of your wife if you have got one; or, if you have not, the way you can if you get one and don't like her. He ties the woman up tightly in a net first, and, when he has done that, he puts a basket on the ground. He then takes the top off, and proceeds to put her into the basket. There is the unhappy wife in the basket. The little boy plays the tom-tom, beating it all the time, the fellow standing looking on. As soon as the woman is packed up, he covers up the basket, and, seizing a sword, he plunges it in. The woman shrieks and yells frightfully, the blood pours out in torrents, the ladies who are looking on faint, and the gentlemen curse and swear, and pull him away. When they tear open the basket, they find it empty, and the woman comes out of the house where you are staying

and asks for bakshish. This fellow is succeeded by two other jugglers, who spread a cloth before you over the sand, and in some mysterious way cause a fine large branch of the mango-tree to appear, and grow up under the cloth. It is a curious fact that in Egyptian history we read of the same trick with the lotus-tree as this with the mango-tree.

Now we come to the snake-charmers, the most wonderful race of men in the whole of India. They take up a cobra, the most deadly of all reptiles, and still hardly ever are bitten. There is the photograph of these snake-charmers before you. The snakes are never still. The poison-bag is in the roof of the mouth; and, by certain means, this bag is pressed, and the poison ejected. But, when you remember that two hours is about the limit one lives after the bite of a cobra, you cannot help wondering at the carelessness of these fellows. And though nowadays they say that by ejecting certain alkali, ammonia, or something of the kind, into the blood, the bite can be cured and the poison destroyed, yet still, in the wilds of India, who would be able to do this in the short space of time allowed to live after having been bitten? There is one little animal alone that enjoys exemption from the fearful bite of the deadly cobra. It is a favorite amusement to some people to watch the struggle. They will turn a large cobra loose in the room, and then immediately place a *mongoose* before it. The mongoose instantly attacks the cobra, and a desperate fight ensues; the cobra bites the mongoose over and over again, but the poison seems not to have the slightest effect on it, and the battle will certainly result in the death of the cobra. If the mongoose dies, it is from sheer loss of blood and exhaustion, and not from the effects of the poison, as thousands can testify. Dr. Short has held for many minutes the mouth of a cobra fixed on to a mongoose, but it has got up and run away, without any hurt. What peculiar antidote he possesses science has not yet been able to discover.

Having now taken a cursory view of Madras and its people, and the jugglers, such as they are, we pass on to consider their religion and their temples.

First, I must tell you that the word temple does not exist in India. It is merely a word imported by us. The word they use is *devila*, and means the house of God. A temple does not consist of one, but four component parts. What we generally call a pagoda is nothing but the gopurum, answering to the Egyptian pylon over the door. The four parts of each temple are the *gopurum*, or door; the *mundapum*; the *teppa kolum*, or tank; the *vimanum*, or sanctuary.

Now, I propose to show you these, and give you some idea of what they are. We will take the train at night from Madras, and at twelve next day we find ourselves at Trichinopoly, close to which is one of the largest and finest temples in all India. The view is taken from the gate-way at the south entrance. The pyramids are called the gopura,

and mark the entrance into each separate court. The houses are inhabited by 8,000 Bramins, who are not all necessarily priests; but, like the tribe of Levi among the Jews, from whom the priests were taken, so among the Hindoos the priests are taken from among the Bramins. The others hold their shops in the temple. There are 21 of these gopura; the large gopurum to the right is 300 feet high. The next view gives the gopurum more in detail, and shows it exactly as it is. The lower part is of stone, the upper part of brick, and this is covered with figures, representing different scenes in their holy history. Sometimes these gopura are very much more ornamented than others; but they are always for the same purpose, that is, to cover the entrance into the different parts of the temple.

We now come to a mundapum. A mundapum may be composed of simply eight stones. Take four stones and put them upright in the ground, about eight feet high; put the other four along the top, and you have got a mundapum, and such exist in thousands all over India; and, whether elaborate as this is, or perfectly plain, whether square, or round, the result is the same, and you have a mundapum. In this case each pillar is one single block of granite, out of which those figures 15 feet high have been carved; it is covered with a flat stone roof. It constitutes one of the finest mundapa in India.

We next proceed to look at a teppa kolum, or tank, as you see here. The god not only is treated in every way like a human being, but he must have his excursion in the water, and his ride in the car—21 times he goes round that centre pavilion you see in the middle. On the left and on the right you see mundapa, and the small gopurum covers the entrance into the sanctuary.

I may as well tell you that the sanctuary is nothing but an oblong building, perfectly plain, dark as pitch, not the smallest glimmer of light being admitted. No European is ever allowed to enter it, except a prince of royal blood, and he must enter it alone; and, if any other European, or heathen, or low-caste man, dares to put his foot inside the sacred portals, the temple must be abandoned, or the man must die. Such is the rule of the Hindoos.

I will just show you, in passing, the interior of a mundapum—that is, a very plain one—one of those we just saw the outside of. That curious thing in the middle, called a flag-staff, was used formerly to mark the distance a man was allowed to approach toward the sanctuary. He was not allowed to pass nearer than that. But gradually it has fallen into disuse, and now he may walk within three or four yards of the sanctuary-door. It is so dark, though, that nothing can be seen.

Passing from Trichinopoly we here leave the railway, and have to choose the way we will travel. There are three ways before us. We can go on horseback, and, starting an hour before sunrise, and galloping all the time till the sun rises, accomplish 12 or 14 miles at the out-

side. The next way, which is more comfortable by far, is by the palanquin, carried by men on their shoulders, and you go along very easily. But if you are heavy it is a great misfortune, for more bearers are required to carry it, and consequently more money to pay them. But this is now almost obsolete, except in the native states, and so you are obliged to fall back upon the bullock-coach, which I will show you.

That is the vehicle in which you have to travel all over the south of India, except on the few spots where there may be railroads. This one is occupied by natives; turn them out and get in, and be sure to sleep with one eye open, or you will not travel very far. If you close your eyes the man will immediately stop, and the bullocks will lie down and go to sleep too, and the man will get under the carriage, and you will be lucky if you get over two miles instead of twenty. I have known a native go three times round his own village, and come back to his own door, and when you awoke, thinking you were twenty miles on the road, and routed him out from his own house, and asked him where it was, he would tell you it was a village eight or nine miles off, but you saw it was the same man and the same bullocks, which you ought to have changed long before getting that distance.

Nominally, there are plenty of roads in India, and good ones, too. The government pay enormous sums to keep them in repair. The contractors are natives, and they keep them in good order for five or six miles out of the town where the Europeans are likely to drive, because if they saw bad roads they would make a row; but nothing is more execrable than they are farther on; there are holes big enough and deep enough to bury a man in; you will often be 24 hours doing 12 miles.

However, we go on to Madura, the Rome of India. It is one of the largest and most noted places, and has one of the richest temples. The first building we are going to see is a mundapum. Opposite the entrance to all these mundapa are what are called the guardians of the gods, of which you see one here. There he stands, carved out of a single block of granite 15 feet high, beckoning with one hand, and with the other warning you not to come unless you are properly prepared, with his foot on the head of a cobra—whether typical of the triumph of the Hindoo religion over the worship of the serpent, is a question I dare not go into, for it is enough to mention that one subject among *savants* and you set them all arguing. However, passing in beyond this, we see one of the most beautiful buildings in the whole of India. It is a mundapum, and was built by the last King of Madura before we took it. It cost one million of money, and took 22 years to build. The story is, that the reason of his doing so was that he asked the god to come and pay him a visit. The god said he had no objection, but he had not a house fit to receive him in. So the king at once set to work and built what you see, and, though he is long since dead and gone, the god is brought ten days every year to pay a visit to this mundapum. It is 333 feet long and 84 feet wide, and is considered

by all to be one of the finest in India. It is built of pure gray granite. Every pillar in it to the right and left is whitewashed. The natives always whitewash them to a certain height. On each side are representations of the king and his successors. You see him on the right under his canopy, and beside him his two wives. The story goes that Trimul Nayak married a daughter of the Rajah of Tanjore. The day after he brought her home he took her to see this magnificent building, which was just completed. After walking through it, as she did not say a word, he asked her why she had not spoken, and what she thought of it. She answered that her father had a better stable for his horses. In a fury he drew his dagger and stabbed her in the side, and it is said that, when the pillar was cut, and they sculptured the figure of the wife, the hole appeared in the side; and, although they changed the pillar three times, every morning after, they found the hole still there, as a warning to passionate husbands to keep their tempers. One of the pillars outside this temple, being very much exposed to the weather, is consequently much damaged. It represents Vishnu giving his sister in marriage to Siva, and every year there is a cermony of marriage performed. But, while the ceremony is going on, a Bramin invariably sneezes, and as that is an omen of bad auspices, the marriage is postponed, and, as this has been going on year after year, it probably will to all eternity. That sneezing puts a stop to it.

The outside of this celebrated mundapum is similar to that we saw before at Trichinopoly, the two side-pillars being carved differently, the one on the right being Ravana, the celebrated giant, who was condemned to bear a mountain on his back in punishment for his sins. Exactly opposite is situated the celebrated Temple of Madura, the richest in India, with an income of £4,000 a year, and an enormous number of priests. The difference between this and the other at Trichinopoly is that this is all covered over, while that is uncovered. That one is very poor, while this is enormously rich. I ought to have said a few words here respecting Hindoo worship. There is not a single Hindoo temple dedicated to the worship of the one God, and they have no representation of Him. He is something too awful for that. They never address Him except through a priest, or one of his personifications, Brahma, Vishnu, and Siva. These are the three principal deities. Brahma is Creation, Vishnu is Preservation, and Siva Destruction. And, although it is said that there are 330,000,000 gods in India, yet the simple truth is, all these are only names given to one or other of these in any particular place where the god is worshipped. He is always named for some act or other which he is supposed to have performed at or near the place of worship. One or other of these three is the god, and there are 330,000,000 names of these gods. That is the whole secret of the Hindoo religion.

Passing into this celebrated temple, we come to the golden lotus-tank, one of the most celebrated tanks in India. It is supposed that

in this temple originally there was no tank, and so Siva was obliged to make a passage under the sea to allow the water of the Ganges to come a thousand miles and supply this tank with water. Alongside this tank there was a bench, and there was a sect of holy men who had a right to sit upon it. This bench had the peculiar faculty of elongating itself at pleasure, or becoming shorter, as the case might be, and therefore, when anybody applied to be admitted a member of this holy sect, he was ordered to sit on the bench. If the bench elongated, he was to be received as a member; if the bench became shorter, he went head over heels into the water, and could not become a member; and, as the water was in a very foul state, he did not have a very pleasant bath.

Now we come to the Palace of Madura. It formerly covered a square mile of ground, and was a most splendid building. Every pillar you see is 50 feet high. There is very little of it left now, and what little there is, is used as a court of justice every day in the season. The next view will give you a better idea of this wonderful place. It is taken from the inside, looking outward, and gives a side-face view of the square, three sides of which still stand. The interior of one of the colonnades also gives a very good idea of the grandeur of the place.

We now strike across the sea-shore, and on going a little to the north we cross a small arm of the sea, and come to Ramisseram, which has the most celebrated temple in the south, if not in the whole of India. Its corridors are considered the finest in the south—the door at the end marks the entrance to the sanctuary—they are 300 feet long; each pillar is one block of solid gray granite. Unfortunately, from its being whitewashed, much of the beauty is hidden. If at any future day it should be cleaned, it will, of course, be in a better state of preservation thereby.

This gives an idea of the strange way the Hindoos sculpture the pillars in their temples. The figure is nothing but that of a juggler, and yet he is carved out of one of the pillars in one of the most sacred temples in India. The side-aisle of the Temple of Ramisseram is 700 feet long; the window at the end is five feet high, and gives some idea of its length. When we consider that the pillars are of granite, and the enormous time it must have taken to build such a temple, and carve such a wonderful corridor, I think you will agree with me that it is a work which the world can hardly excel. Four thousand feet is the aggregate length of the corridors. The temple is situated at the edge of the sea, and receives the pilgrim after his long and toilsome march of 3,000 miles from the north. Only those who know what Indian travel is can conceive what he must have gone through; when he leaves the Ganges he is laden with bottles, one of which he is bound to leave at every temple till he arrives here, and leaves the last, and here he hopes for rest. But he has no rest yet, for the Bramins take him to the sea, and the actions they make him go through at daylight are very absurd. Then, between here and Ceylon, is a long sand-bank,

seven miles long, which formerly was a portion of the land, and through this the pilgrim is condemned to wade to a temple built on a rock. At last the Bramins have done with him, and he finds rest and repose here. He wanders through the splendid corridor late in the evening—in the dark night—and knows he has earned the right to remain. He feels that he has insured to himself beatitude hereafter, and, he hopes, prosperity in this world.

Before finishing, I must ask you to understand what Indian caste is. It is compared to our society, but in reality is very different from it. A high-caste man, no matter what his position, though he may be a beggar and perform the most extraordinary offices, still always has the right of *entrée* into the houses of the richest natives, and is welcomed wherever he goes, and always received well. On the other hand, a low-caste man, though with millions of money, is never allowed to enter a temple. Among the higher caste are the fakirs. There is one, such as I saw him. He confessed to me that water had never touched his body, his nails had never been cut, he had never been shaved, and his hair was bound up with rags, and was a solid mass of dirt and filth, and yet this man was received with open arms in the magnificent palaces of the rich natives, where he was always welcome. Such as I saw him I show him to you.

TO FREDERICK A. P. BARNARD.[1]

THE years are many since, in youth and hope,
Under the Charter Oak, our horoscope
We drew thick-studded with all-favoring stars.
Now, with gray beards, and faces seamed with scars
From life's hard battle, meeting once again,
We smile, half sadly, over dreams so vain;
Knowing, at last, that it is not in man
Who walketh to direct his steps, or plan
His permanent house of life. Alike we loved
The Muses' haunts, and all our fancies moved
To measures of old song. How, since that day,
Our feet have parted from the path that lay
So fair before us! Rich, from life-long search
Of truth, within thy academic porch
Thou sittest now, lord of a realm of fact,
Thy servitors the sciences exact;
Still listening, with thy hand on Nature's keys,
To hear the Samian's spheral harmonies
And rhythm of law. I, called from dream and song,
Thank God! so early to a strife so long
That, ere it closed, the black, abundant hair
Of boyhood rested silver-sown and spare
On manhood's temples, now at sunset chime
Tread with fond feet the path of morning-time.
And if perchance too late I linger where
The flowers have ceased to blow, and trees are bare,
Thou, wiser in thy choice, wilt scarcely blame
The friend who shields his folly with thy name.

AMESBURY, MASS., *Tenth Month*, 1870.

[1] Whittier's beautiful dedication of "Miriam" deserves a wider circulation than it has received.

EDITOR'S TABLE.

COERCION IN EDUCATION.

THE question of collegiate reform has again broken out in public discussion. Dr. McCosh has written a letter to the *Evening Post*, protesting against certain contemplated changes in the management of the students in Harvard University. It is proposed to abolish the compulsory recitations, to allow the students greater freedom, but to hold them rigorously to the final examinations — a proceeding which Dr. McCosh thinks is not only in itself mistaken, but, by its adoption in so influential an institution as Harvard, would exert an injurious influence on other colleges of the country. The immediate question is that of college discipline. While there is a great stir in behalf of general compulsory education, Harvard proposes to relax its coercive practices. President Elliot, in his report to the Board of Overseers, suggests that the time has come for allowing more liberty to students, and, as their average age of admission to his institution is now above eighteen years, he thinks that the school-boy tactics might be dispensed with, and the students be treated more as responsible men, preparing for the work of life. Dr. McCosh holds, on the contrary, that the college is a place for discipline, which is to be acquired by the enforcement of external rules and the close supervision of the students by tutors, and the method of enforced recitations.

President Elliot assumes that the policy of European universities is more free than that of American colleges, and in this respect is worthy of our imitation. Dr. McCosh denies this. He says: "In all the good colleges of Great Britain and Ireland, the tendency of late years has been toward a weekly or daily supervision of studies. In Oxford and Cambridge, which have produced such ripe scholarship and high culture, the teaching is conducted, not by loose lectures of professors, but by numerous erudite tutors, who may not have more than half a dozen pupils present at a time, possibly not more than one, but who rigidly insist that the pupils be present and do their work." In regard to the German system, Dr. McCosh states that the *Gymnasien* and *Realschule*—the preparatory schools—take charge of the pupils from the age of ten or twelve to eighteen, and carry their scholarship as far as the freshmen or sophomore classes in our American colleges. And he says that at these institutions "attendance is rigidly required, and the instruction is of a thoroughly drill-character. Every one ought to know that the foundation of German scholarship is laid, not in the universities, but in the Gymnasien. In the universities of Germany there is much to commend. Berlin, with its two hundred teachers, can furnish high instruction in every department of human learning. It is the very place for an American youth to go to, when, having taken his degree at home, he wishes to perfect himself in some special department of scholarship. At all the universities a few studious youth work with great assiduity and success. But a very large portion are not studious, and take a deeper interest in beer-drinking, *Burschen* songs, and sword-duels, than in careful reading."

The question here raised is not to be settled by European precedents, because—first, as we see, the doctors disagree as to the facts; and, second, because it is a radical question affecting our whole educational system, and can only be settled by an appeal to first

principles. The difficulty encountered is by no means confined to the higher institutions; it is coextensive with all modes of public education, and is just as palpable and refractory in the middle and lower schools as in the colleges. The trouble arises from the massing together of students of unequal moral and intellectual capacities. Between those of superior and inferior grade, there is an undoubted antagonism of interests and requirements. The management that is best suited for the one class, under existing views of education, is not best for the other, and we see in every school the evils that arise from uniformity of system. For the development of the highest character, self-restraint and self-direction, with free and responsible action, are indispensable; and, in every school, there are those who are capable of this self-education, and who suffer from a meddlesome and offensive coercion. On the other hand, there is the great majority who seem to require external direction and police supervision, and of whom, perhaps, little can be made under any system. Which shall be sacrificed?

That there is a tendency to escape from the low agency of external rules and regulations, and to give greater scope to the principle of individual self-government, is unquestionable. President Elliot's remark, that "the time has come for allowing more liberty to students," is but the recognition of a great change in regard to the best method of controlling human beings in all branches of social regulation. With the gradual disappearance of slavery within the sphere of civilization; with the decline of political tyranny and interference with the individual; with the relaxation of the severities of family government, and the management of apprentices; with the passing away of religious coercion in matters of belief, and with the substitution of the principles and practice of non-restraint for the old methods of violence, even in lunatic asylums, there has been a corresponding change in the school-room; its barbarisms of discipline have ceased, and the question is now one mainly of the degree of supervision. Many evil consequences undoubtedly flow from this profound transition, but it must be accepted as an on-working of humanity, and a phase of the action of Nature. To assume that the forces in play have now reached their final equilibrium, we think is irrational, and to arrest the movement at its present stage we hold to be impossible.

It is now virtually conceded that the highest results of scholarship in the universities are not attained by the coercive drill-system. Speaking of the German institutions, Dr. McCosh says that "at all the universities a few studious youth work with great assiduity and success; but a very large portion are not studious, and take a deeper interest in beer-drinking, songs, and sword-duels, than in careful reading." Such is the outcome of that thorough-going preliminary drill which characterizes the lower or preparatory schools of Germany. The passage of students from these to the universities is regarded as an escape from drudgery, which produces a vicious reaction when the sphere of freedom is reached. At all events, this thorough drill-system is a failure with the great mass of students. It is the same in England. Dr. McCosh speaks of "the ripe scholarship and high culture" which marked the educational policy of Oxford and Cambridge, but this description is applicable to but a very small proportion of the students. Notwithstanding the vigorous coercion of discipline in the great public schools which prepare for the universities, and notwithstanding the supervision that Dr. McCosh alleges in the universities themselves, the number of whom ripe scholarship and high culture can be affirmed is scandalously few. Whatever truth there may be in Sydney

Smith's remark that the universities are in the habit of taking credit for all the mind they do not succeed in extinguishing, it is pretty certain that the small number of graduates who give character to the school are those who would succeed under any system. So far, indeed, as the great body of the students are concerned, there is small ground for boasting of the success of the English system. When we consider the wealth and resources of the English universities and great public schools, when we remember their ancient prestige, the talent at their command, and their high place in public confidence, in the light of the results produced, we can cordially agree with Prof. Blackie, of Edinburgh, in his letter to Dr. Hodgson, when he pronounces the whole system "a superstition, a blunder, and a failure."

School-discipline can never be divorced from the nature of school-occupation. If the studies are repulsive, if they do not take hold of the feelings, or if they produce indifference or antagonism, force is the teacher's only alternative, to keep the school in order, and carry on its work. The essential implication of coercion in influencing conduct is a penal policy. A compulsory system is one that punishes for a breach of rules. In civil society, where the object is simple protection, government has nothing to do but to attach penalties to the violation of law. But it is widely different in education, the object of which is to incite the student to put forth his energies; for, in the end, all true education is self-education. But a punitive system appeals to the lowest motive, the fear of the infliction of some form of pain, and it can never stimulate to the best or highest action. In the past history of education, flogging has been its almost constant accompaniment, and this has been coincident with schemes of study that have failed to enlist the sympathies of pupils, and to quicken their nobler emotions. Take the one element of language, the study of which constitutes the staple of school-drudgery, and which is habitually pursued as arbitrary and irrational task-work, and what can we expect but that students will require to be *driven* through the irksome routine of daily toil. Prof. Halfourd Vaughn indulged in no exaggeration, when, called before a committee of the British Parliament to testify as to the working of the English system, he said: "There is no study that could prove more successful, in producing, often thorough idleness and vacancy of mind, parrot-like repetition and sing-song knowledge, to the abeyance and destruction of the intellectual powers, as well as to the loss and paralysis of the outward senses, than our traditional study and idolatry of language." Two hundred years ago, Milton criticised the education of his time from exactly this point of view. He denounced it unsparingly, and went so far as to declare that a better system was not only possible, but might do more even for dunces than the prevailing method could do for brighter minds, and he put the statement in the following quaint and pungent form: "I doubt not that ye shall have more ado to drive our dullest and laziest youth, our stocks and stubs, from the infinite desire of such a happy nurture, than we have now to haul and drag our hopefullest and choicest wits to that asinine feast of sow-thistles and brambles, which is commonly set before them as the food of their tenderest and most docible age."

THE FAREWELL BANQUET TO PROFESSOR TYNDALL.

Prof. Tyndall having closed his labors in this country, has sailed for home. His work has made a deep impression upon the public mind, as was testified by the farewell dinner given in his honor in this city, before leaving. The affair was, in several respects, re-

markable. No such brilliant gathering of scientific, literary, and professional gentlemen has ever before assembled on a festive occasion in this metropolis. As his lecture-rooms, in the various cities he has visited, have been crowded by the most intelligent and cultivated people, so the dining-hall at Delmonico's was filled with two hundred guests, many from abroad, and representing the colleges and scientific institutions of the country, together with a large body of the most eminent gentlemen of our city. The spirit of the occasion was one of harmonious enthusiasm for the distinguished professor in whose honor it was made, and of lively interest in the subjects and ideas he represents. The speaking was excellent, and, although graver and more didactic than is customary at such times, was yet by no means unexciting, and met with the most cordial responses. Of course Delmonico, prince of caterers, lost no reputation in the elegant and sumptuous repast which he furnished, but the social and intellectual treat was the great feature of the evening. Prof. Tyndall made a happy address, in which he explained the motive of his coming to this country, the laborious character of the work which his lectures involved, and the reasons which compelled him to decline the numerous urgent invitations that have poured in upon him from all directions, to lecture in the cities of the interior and the West. We have no space now to refer to the several admirable speeches that were made, upon subjects variously connected with the interests of science. They were too valuable to be left in the incomplete shape in which the reporters gave them to the newspapers, and they will be shortly published as an appendix to the little volume of his lectures which Prof. Tyndall has carefully prepared, and which will be given to the public in a few days.

LITERARY NOTICES.

THE EARTH A GREAT MAGNET. A Lecture delivered before the Yale Scientific Club. By ALFRED MARSHALL MAYER, Ph. D., Professor of Physics in the Stevens Technological Institute. Chatfield & Co., New Haven.

THE author of this lecture is well known to the scientific world, both in this country and Europe, as an original investigator in the field of physics. He has made numerous researches in various physical branches, the results of which have been published in the scientific journals, domestic and foreign. He is now prosecuting various inquiries at the Stevens Institute of Technology, in Hoboken, where they have the finest collection of physical apparatus that can be found in any institution in this country, if not in the world. Having won his spurs as an original experimenter, and established his place among those who extend and create scientific knowledge, he now turns his attention to the work of diffusing it among the people. It is common to say that original investigators are not good expositors; and this is often true, but it is also true that they are frequently the very best of teachers. We have recently had a conspicuous example of this in Prof. Tyndall, and we now have another in Prof. Mayer. The lecture before us is a model, in its logical form, its copious and beautiful experiments, and its lively and graphic language. As an exposition of the elements of terrestrial magnetism in a compressed and readable form, it is perfect. Trübner, of London, has caught it up and issued it; and the *London and Edinburgh Philosophical Magazine*, the first scientific authority, has reviewed it in so just and discriminating a way that we cannot do better than to quote a portion of its statement: "This is the report of a lecture delivered before the Yale Scientific Club on February 14, 1872, in which the lecturer proposed to present to his audience '*one prominent truth* in simple and striking experiments.' The truth which is kept steadily before the mind throughout the lecture is, that the earth is a great magnet; and this truth is developed step by step by experiments of the most conclusive kind, each having been rendered distinctly

visible to the audience by means of the *vertical* lantern, so that the processes of demagnetizing, with all the interesting motions of the needles, were seen projected on a luminous screen, eighteen feet in diameter.

"The lecture itself is a masterly production, and exhibits the result of much close reading as well as experimental research. Quotations are given from earlier writers on magnetism, illustrative of the sound knowledge which they possessed; and, as each experiment illustrative of the lecture is described, as well as the apparatus employed in manipulation, the reader is conducted from a consideration of the most ordinary magnetic phenomena presented by bar and electro-magnets to that of the same phenomena evolved from terrestrial magnetism. A paragraph selected from the closing portion of the lecture will fully substantiate this statement: 'Now we have finished our experiments; and what have they shown? I have temporarily magnetized a bar of soft iron, by pointing it toward a pole of our large magnet. I did the same with the bar and the earth. I permanently magnetized an iron bar by directing its length toward the pole of the magnet, and vibrating it with a blow of a hammer. I did the same with a bar, struck when pointed toward the earth's magnetic pole. I have shown you the action of a small magnetic disk on iron filings placed above and around it. You saw the earth produced the same action on the beams of the aurora. I showed you the action of this disk on a freely-suspended magnetic needle, and pointed out to you the earth's similar action on a dipping-needle carried over its surface. I have evolved a current of electricity from a magnet, by cutting with a closed conductor across those lines in which a magnetic needle, freely suspended, places its length. I did the same with the earth by cutting across those lines which are marked out by the pointing of the dipping-needle. Therefore, what am I authorized to infer? When the effects are the same, the causes must be the same; for, according to all the principles of philosophy, and conformably to that universal experience which we call common-sense, like causes produce like effects.'"

FAMILY THERMOMETRY. A Manual of Thermometry for Mothers, Nurses, Hospitallers, etc., and all who have charge of the Sick and of the Young. By EDWARD SEGUIN, M. D. Pp. 72. Putnam & Sons.

THIS is a valuable monograph upon an important subject, and is an interesting indication both of the progress in medical science, and of the need and possibility of diffusing its benefits among the people. More and more as physiology and pathology advance, are we discerning the fundamental nature of the thermal processes in the living economy. That the animal body is, first of all, a furnace to which the digestive system furnishes fuel, and the respiratory system the agent of combustion, is not a mere curious chemical fact, but it is a central and vital physiological law, which is involved with the whole subject of health and disease, of life and death. It may not be proper to say that heat is life, but it is an essential condition of it, and is unquestionably the raw material of it—if not life, it is yet transformable into life. But the organism generates its heat and loses it by fixed physical laws, while the whole scheme of its activities depends upon the maintenance of the vital temperature at a given point, the *norme* of health, which is 98° Fahr. in the Caucasian race. Any deviation from this point is an indication of disturbance and disease. The rise of temperature above the standard involves one class of disturbances; its fall below, another class. The physician alone can deal with the special complications which arise when the temperature ascends or sinks abnormally, but it is in the power of those not physicians to observe the indications, and thus to determine not only when the medical man should be called, but to furnish him with positive and valuable data for his treatment. The use of the thermometer has become indispensable in intelligent medical practice, but Dr. Seguin has shown that it is equally indispensable to mothers in the intelligent management of their children. The only difficulty is to get them to use it, and to give a little attention to the method of registering the results observed. The ordinary thermometer is badly graduated with reference to this use, and so Dr. Seguin has devised a physiological thermometer marked in so simple a way that it may be employed by anybody

with facility. The health-point, or *norme*, is marked zero; O = H, or health. From this point, in fever, the index runs up, and, in depression, it runs down, proportionally to the danger in both directions, the points of significance being indicated upon the scale. Careful directions are given for using the instrument, and simple charts are prepared for recording the observations. These charts, and the systematic records they contain, are indispensable as forming a history of the case, for it is not only the deviations of temperature, but the train of variations and intermittent changes, that it is desirable to know. Dr. Seguin says: "The supreme importance of the first observation of the first abnormal temperature, at the first moment of a sickness, cannot be overrated. If it rarely shows, by name, what the intruding illness will be, at least it can often, by exclusion, tell what it will not be. For instance, a high first temperature, as of 3 to 4° above the point of health, cannot herald typhoid fever, but can measles or scarlatina. Moreover, the first observation serves as a mile-post to start the reckoning of the future stages, of increase or effervescence, of full force or diminution, of convalescence or relapse." Dr. Seguin observes: "The A B C of motherhood is the name I would give to that part of nursing which mainly consists in spying the subtle and bold invasion of disease, and of measuring from the first its deadly strides into the vitals of the innocent. The mother who can do that is the sentry. When she detects the moment of the invasion of the cradle, and measures the strength of the enemy on the stem of her thermometer, and can transfer and read its warnings on her chart, she is prepared for the struggle with death itself." Yet there is a difficulty here which Dr. Seguin has not been slow to perceive, and which he states without reserve or circumlocution. He says: "But where shall we find a mother who has been taught her duty in that matter of life and death? No use to mince it; it is a shame and a scandal that, in the curriculum of education devised for our sisters and wives, there is room for algebra, trigonometry, etc., and none for the fine art of nursing; that they are taught to look through microscopes and telescopes, but not in the faces of the little ones to read therein health or sickness; that they can tell the latitude of Peking, the height of Chimborazo; know at what point potassium fuses, or mercury solidifies, but that not one ever heard at what point of elevation of the latter metal in a thermometer life escapes from their dearest."

THE FORCES OF NATURE. A Popular Introduction to the Study of Physical Phenomena. By AMÉDÉE GUILLEMIN. Translated from the French by Mrs. NORMAN LOCKYER, and edited, with Additions and Notes, by J. NORMAN LOCKYER, F. R. S. Macmillan & Co.

THE novel and interesting feature of this book is its profuse and sumptuous illustrations. Its author has won some reputation as a popular writer on science, and the work has evidently lost nothing in translation and editing; yet its text alone would give it little claim to attention. The pictorial part of the work is not only copious and varied, but is finely executed, and renders the volume both attractive and instructive. It has no value as a text-book, and not much as an authority for reference; but it may be read with pleasure, and many of the illustrations cannot fail to be helpful to the student. The work is unique as a popular scientific luxury.

EPIDEMIC CEREBRO-SPINAL MENINGITIS. With an Appendix. By MEREDITH CLYMER, M. D. Philadelphia: Lindsay & Blakiston. 1872.

IN this little work, which is mainly a reprint of the author's additions to Dr. Aitken's "Science and Practice of Medicine," we have, in compact form, a large amount of valuable information concerning one of the most dreaded, because most deadly, of man's diseases. As first published in 1866, and revised two years later, Dr. Clymer's monograph contained a sketch of the geographical and clinical history, the pathology and treatment of cerebro-spinal meningitis, as also, under the head of "Etiology," a brief account of the conditions attending outbreaks of the disease, and a very full list of authors upon the general subject. This new edition contains all the matter of the first two, and has, besides, a most valuable appendix, which deserves to be in the hands of every family that is capable of

studying intelligently its own welfare. This portion of the work was prepared on the heels of the terrible epidemic of cerebro-spinal meningitis in New York during the first six months of last year, when, out of 790 persons attacked, 607 died. Availing himself of the records of the Health Department, and of the observations of Dr. Russell, Registrar of Vital Statistics, the author has been able, in this appendix, to throw much light upon the vexed question of the causes of the disorder. Thorough investigation proved these to be filth, overcrowding, defective sewage-pipes, and the like. It would appear that the disease is not propagated by contagion or infection, and consequently its origin must be ascribed to unwholesome conditions in the household or neighborhood where it manifests itself. If the public would be awake to the dangers they may themselves be creating, they would do well to procure this book, and give the appendix, at least, a careful perusal.

THE following discriminating notice of "Physics and Politics," from the pen of Prof. John Fiske, appeared in the February *Atlantic*. It gives so clear an insight into the quality of that remarkable little volume, that our readers will thank us for reproducing it:

"If the International Scientific Series proceeds as it has begun, it will more than fulfil the promise given to the reading public in its prospectus. The first volume, by Prof. Tyndall, was a model of lucid and attractive scientific exposition; and now we have a second, by Mr. Walter Bagehot, which is not only very lucid and charming, but also original and suggestive in the highest degree. Nowhere, perhaps, since the publication of Sir Henry Maine's 'Ancient Law,' have we seen so many fruitful thoughts suggested in the course of a couple of hundred pages.

"The principal aim of Mr. Bagehot's book is to point out some of the conditions essential to progress in civilization, and to show how it is that so small a portion of the human race has attained to permanent progressiveness. It has been customary to contrast man with inferior animals as alone capable of improving his condition from age to age; the implication being that, while none of the inferior animals show any capacity for progress, on the other hand all men, without distinction save as to degree, possess such capacity. And some metaphysical writers have gone so far as to describe progressiveness as a tendency inherent in humanity. The gulf between man and other animals, wide enough in any event, has in this way been unduly exaggerated. In reality it need not take a very long survey of human societies, past and present, to assure us that beyond a certain point stagnation has been the rule, and progress the exception. Over a large part of the earth's surface the slow progress painfully achieved during thousands of prehistoric ages has stopped short with the savage state, as exemplified by those African, Polynesian, and American tribes which can neither work out a civilization for themselves, nor appropriate the civilization of higher races with whom they are brought into contact. Half the human race, having surmounted savagery, have been arrested in an immobile type of civilization, as in ancient Egypt, modern China, and in the East generally. It is only in the Aryan race, with the Jews and Magyars, that we can find evidences of a persistent tendency to progress; and that there is no inherent race-tendency at work in this is shown by the fact that some of the Aryans, as the Hindoo, and Persians, are among the most unprogressive of men. The progress of the European Aryans, like the evolution of higher forms of life, has been due only to a concurrence of favorable circumstances.

"It is one of the puzzles of sociology that the very state of things which is preëminently useful in bringing men out of savagery, is also likely to be preëminently in the way of their attaining to a persistently progressive civilization. 'No one,' says Mr. Bagehot, 'will ever comprehend the arrested civilizations unless he sees the strict dilemma of early society. Either men had no law at all, and lived in confused tribes, hardly hanging together, or they had to obtain a fixed law by processes of incredible difficulty. Those who surmounted that difficulty soon destroyed all those that lay in their way who did not. And then they themselves were caught in their own yoke. The customary discipline, which could only be imposed on any early men by terrible sanctions, continued with those sanctions, and killed out of the whole society the propensities to variation, which are the principle of progress.'

"A word to the wise will suffice to show that Mr. Bagehot has here struck nearer to the explanation of the arrested civilizations than any previous writer. Among numer-

ous tribal groups of primitive men, those will prevail in the struggle for existence in which the lawless tendencies of individuals are most thoroughly subordinated by the yoke of tyrannical custom—the only yoke which uncivilized men can be made to wear. These communities will grow at the expense of less law-abiding tribes, until the result is a strong nation ruled by immovable custom, as in the case of Egypt, or China, or India. The problem now is how to get beyond this stage, and to relax the despotism of custom without entailing a retrogression toward primeval lawlessness. This problem has never been successfully solved except where a race, rendered organically law-abiding through some discipline of the foregoing kind, has been thrown into emulative conflict with other races similarly disciplined. And this condition has been completely fulfilled only in the case of the migrating Aryans who settled Europe.

"This is but one of Mr. Bagehot's many bright thoughts. We have barely room to hint at another. It was formerly assumed that, instead of mankind having arisen out of primeval savagery, modern savages have fallen from a primeval civilization, having lost the arts, the morals, and the intelligence which they originally possessed; and in our time some such thesis as this has been overtly maintained by the Duke of Argyll. Mr. Bagehot shows that in every way such a falling off is incompatible with the principle of natural selection. Take, for example, the ability to anticipate future contingencies—to abstain to-day that we may enjoy to-morrow. This is the most fundamental of the differences between civilization and savagery.. Now, obviously, the ability to postpone present to future enjoyment is, in a mere material, economic, or military aspect, such an important acquisition to any race or group of men, that when once acquired it could never be lost. The race possessing this capacity could by no possibility yield ground to the races lacking it. Or take the ready belief in omens by which the life of the savage is so terribly hampered. Could a single tribe in old Australia have surmounted the necessity of searching for omens before undertaking any serious business, it would inevitably have subjugated all the other tribes on the continent. So, because the men who possess the attributes of civilization must necessarily prevail over the men who lack these attributes (and this is always true in the long-run, though now and then a great multitude of barbarians may temporarily overthrow a handful of civilized men), because this is so, it follows that there cannot have been, in prehistoric times, a general loss of the attributes of civilization.

"To do justice to Mr. Bagehot's fertile book would require a long article. With the best of intentions, we are conscious of having given but a sorry account of it in these brief paragraphs. But we hope we have said enough to recommend it to the attention of the thoughtful reader. We are glad to see that the young science of sociology has received such an early and satisfactory treatment in Dr. Youmans's series of popular books.

BOOKS RECEIVED.

The Ten Laws of Health. By J. R. Black, M. D. Philadelphia: Lippincott, 1872.

The American Chemist. A Monthly Journal of Theoretical, Analytical, and Technical Chemistry. Edited by Charles F. Chandler, Ph. D., F. C. S. Vols. I. and II.

Annals of the Dudley Observatory. Albany, 1871.

The Le Boulengé Chronograph. By Brevet-Captain O. E. Michaelis. New York: Van Nostrand, 1872.

Theoretical Navigation and Nautical Astronomy. By Lewis Clark, Lieutenant-Commander U. S. N. New York: Van Nostrand, 1872.

Primeval Man. An Examination of some Recent Speculations. By the Duke of Argyll. New York: De Witt C. Lent & Co., 1872.

A Century of Medicine and Chemistry. A Lecture Introductory to the Course of Lectures to the Medical Class at Yale College. By Prof. B. Silliman, M. D. New Haven, 1871.

A School *sui generis*. An Essay read before the New York State Teachers' Association at Syracuse. By C. H. Anthony, A. M. Albany: Weed, Parsons & Co., 1872.

The Commonwealth Reconstructed. By C. C. P. Clark. Oswego, 1872.

Introductory Lecture to the Course on Pathological Anatomy at the University of

Pennsylvania. By Joseph G. Richardson, M. D. Philadelphia: Lippincott, 1871.

Juries and Physicians on Questions of Insanity. By R. S. Guernsey, Esq., of the New York Bar

Organization and Constitution of the American Health Association. New York, 1872.

Report on the Water-Supply of the City of Rochester, New York.

Twenty-fourth Annual Report of the Indiana Hospital for the Insane.

Biennial Catalogue of the University of South Carolina, 1871–'72.

MISCELLANY.

Antiquity of Civilization. — M. Oppert read an essay at the Brussels Congress, to show, from the astronomical observations of the Egyptians and Assyrians, that 11,542 years before our era man existed on the earth at such a stage of civilization as to be able to take note of astronomical phenomena, and to calculate with considerable accuracy the length of the year. The Egyptians, says he, calculated by cycles of 1,460 years—zodiacal cycles, as they were called. Their year consisted of 365 days, which caused them to lose one day in every four solar years, and, consequently, they would attain their original starting-point again only after 1,460 years (365 × 4). Therefore the zodiacal cycle ending in the year 139 of our era commenced in the year 1322 B. C. On the other hand, the Assyrian cycle was 1,805 years, or 22,325 lunations. An Assyrian cycle began 712 B. C. The Chaldeans state that between the deluge and their first historic dynasty there was a period of 39,180 years. Now, what means this number? It stands for 12 Egyptian zodiacal cycles *plus* 12 Assyrian lunar cycles.

$$\left.\begin{aligned} 12 \times 1{,}460 &= 17{,}520 \\ 12 \times 1{,}805 &= 21{,}660 \end{aligned}\right\} = 39{,}180$$

These two modes of calculating time are in agreement with each other, and were known simultaneously to one people, the Chaldeans. Let us now build up the series of both cycles, starting from our era, and the result will be as follows:

Zodiacal Cycle.	Lunar Cycle.
1,460	1,805
1,322	712
2,782	2,517
4,242	4,322
5,702	6,127
7,162	7,932
8,622	9,737
10,082	11,542
11,542	

At the year 11542 B. C. the two cycles came together, and consequently they had on that year their common origin in one and the same astronomical observation.

A Plant-Battery. — Under the heading "Arceuthobium shedding its Seed," L. A. M., in the Bulletin of the Torrey Botanical Club, gives the following account of what deserves to be called a vegetable *mitrailleuse:* "I visited the swamp in Warrensburg, the first week in October. I found its female plants of Arceuthobium nearly all gone. Every effort that I made to cut twigs from the matted clumps, where the colonies of these strange parasites grow, brought them down in showers. Fearing that I should fail to get plants with full seed-vessels, I picked a single plant with vessels much swollen. While holding it gently between my thumb and finger, to observe it more closely, I felt the tiniest recoil of the capsule, and the seed struck me a smart blow in the face. I gathered another, and another, and each pretty little bomb went off with a force that must have carried it several feet away. The seed flies out of the base of the capsule, instead of the top; but its position on the plant makes that the top, as, when ripe, the vessels hang with the true summit turned downward. I found the seeds and empty seed-vessels lodged all about on the branches. The plants which have ripened seed fall off nearly all together: those which have not blossomed, or have failed to be fertilized, probably remain for another year. When the seeds are being sown, there must be quite a brisk bombardment going on for several days. Isolated colonies of Arceuthobium in forests may have been planted by seed adhering to the feet of birds."

Government Telegraphy.—The first number of the London *Telegraphic Journal*, in a leading article on Government telegraphy,

has some very pointed criticisms on the working of the new system in England. The end sought by the Government in assuming control of the telegraph interests of the country was, by cheapening the rates and extending the lines, to bring the advantages of the system within the reach of a larger number of people, expecting thereby, just as in the case of the post-office, to derive sufficient income for the maintenance of the lines by the increased patronage that cheap rates would secure. As was anticipated, a large increase of business has resulted; but this very increase promises to defeat the chief advantage which the telegraph is designed to afford, viz., speed of communication. "Speed," says the *Journal*, "is the very essential of the telegram; it is its *raison d'être;* therefore, there is no good in reducing the charge for this convenience, if the convenience itself vanishes. It becomes, in fact, much more expensive. We now pay a shilling for a telegram, when a penny stamp, or even a half-penny card, would have sufficed. In former days a telegram was an outlay, certainly, but we paid much for a speed that we obtained. Many would still pay as much for the same advantage, but find they pay a reduction for a ghost of it." The writer does not despair of a remedy for this state of things, but says that the reticence of the authorities concerning the details of their management prevents the suggestion of any means of relief. The case adds one more to the already long list of examples where the Government plays the part of an obstructive.

Silica as a Basis of Paint.—There was lately discovered in North Wales a deposit of almost pure silica, several feet in depth, which on analysis shows the following constitution: silex, 79 parts; water, 13; oxide of iron, 3; alumina, 4; magnesium, 1. In the manufacture of crystal glass and porcelain this discovery is of considerable interest, but it is perhaps still more valuable as furnishing an excellent fire-proof and water-proof paint. When taken from the bed the silica is freely washed in water, and on being dried it becomes brilliantly white, and is then an impalpable powder. In preparing it as a base for paint, the water is dried out. It mixes readily with pigments and oils, is worked with the greatest ease, and resists the action of acids and of heat. When perfectly dry, the paint is extremely hard and polished on the surface. Applied on the inside or outside of houses, it excludes damp.

White Spots on Photograph Proofs.—Ever since the invention of photography on paper, says the *Moniteur Scientifique*, photographers have been trying to discover the cause of those white points which so frequently appear on their proofs, destroying their value as works of art, and rendering them unsalable. It is commonly supposed that these spots are owing to a defect in the paper—the presence in it of hypochlorite of soda, used by the paper-maker for bleaching purposes. But, as the manufacturers claim that chemical analysis fails to detect in their goods the faintest trace of the hypochlorite, M. Ernest Baudrimont set himself to discover where the fault lay. He first made a thorough analysis of the paper and the size used in taking photographs, but without finding there the cause of the spots. One thing, however, he did discover, which helped him to find the true solution of the problem, and this was that the spots always occurred on the face of the picture, but never on the back. He next artificially produced some spots on a perfect proof, by the employment of the hypochlorite of soda, the hyposulphite of soda, and the cyanide of potassium. After drying the pictures, he applied to the spots a solution of nitrate of silver. It was found that the white spots produced by the hypochlorite and by the cyanide remained totally unchanged, whereas those produced by the hyposulphite very rapidly changed, first to a yellow, then to a brownish tint. M. Baudrimont next touched with the silver solution spots appearing spontaneously on some pictures, and the result was, that at first a yellow point, which soon turned to brown, appeared in the centre of the spots, finally extending over their entire surface. Hence, the author concludes that the white spots occurring in photograph proofs are entirely owing to the hyposulphite of soda, used to *fix* the positive impression. If the proof is not thoroughly washed after the application of the hyposulphite, or if it is dried between

sheets of blotting-paper, which are impregnated with the hyposulphite, from having served the same purpose before, the white points will inevitably make their appearance.

Ancient Ferns.—At a late meeting of the Torrey Botanical Club of this city, Dr. J. Newberry exhibited a fossil fern which he had obtained from the Miocene formation in the western part of the continent. It was an *Onoclea*, and was not distinguishable from the recent Linnæan species, *Onoclea sensibilis*. This certainly carries back the lineage of our common sensitive fern to a very ancient period.

At the same meeting of the club, there was also exhibited a fine specimen of that singular plant which grows parasitic on the roots of the pine-tree, and is hence called, in the Eastern States, *pine-drops*. The plant is rare at the East, and seldom attains the height of two feet. The specimen exhibited was four feet high.

Our Native Birds acquiring New Habits.—In a late number of the *American Naturalist*, Prof. Samuel Lockwood gives an interesting account of that beautiful bird known as the golden robin, or Baltimore oriole, in connection with one of our carpenter-bees. He states that last June large numbers of these humble-bees were found under the horse-chestnut trees, then in full bloom, in the campus of Rutgers College. The strange fact was, that every one of these insects was decapitated, and the heads were lying around with the bodies; further, it appears that every one of the headless bees was a stingless male. The professor worked out the case with much patient perseverance, and found to his surprise that this wholesale slaughter was the work of four orioles. Another fact which astonished him was, that the bodies of all these insects were empty, the viscera having been drawn out at the ring-like opening where the head had been neatly snipped by the birds. The process was to catch the bees while hovering at the ball-like opening of the flowers. After severing the head, they extracted the viscera for the sake of the honey-sac. Several very interesting considerations are brought out in the course of the article—such as the acquired taste; the birds had found out that honey was nice. Was it not singular, too, that they had learned that it could be got in such a manner? And there was also the curious fact that the bird confined its marauding to the white-headed bees, the stingless males—thus carrying on his terrible work with impunity, and almost wantonness, as it contented itself with simply the honey-bearing sac.

Prof. Lockwood also notes a curious change of habit in the kingbird. Speaking of the wonderfully plucky manner of this courageous little bird in attacking crows and other large birds, as securing the general admiration, he says that for himself that admiration has gone down to zero, as he has noticed that the bird has not any true knightly qualities, but can do some very mean things. The professor then instances a case in which a pair of robins had built a nest in a tree so near by that the process could be watched from the house. A pair of kingbirds kept all the time near, and watched progress with genuine royal indolence, and, when all was finished, with kingly impudence took possession. The rightful owners made but a feeble effort to resist this invasion. The kingbirds retained possession until their young were raised.

More than a year ago, Prof. Lockwood likewise called attention to the fact that the great butcher-bird, or Northern shrike, contrary to all precedent, had begun to visit in winter the cities where the European sparrows have become naturalized. The bird in summer collects grasshoppers, small lizards, etc., and impales them on the spines of the locust or other trees, eating them at its leisure. He notices the case in which a shrike in its winter visit gibbeted a sparrow in the city by putting its neck in the crotch of a small branch of a larch, and then, having knocked in the top of its head, the bird extracted its victim's brains.

Paper as a Building-Material.—An English company prepare a water-proof material out of paper-pulp, or any fibrous substance, by saturating it with ammoniated copper solution—a digest of copper scraps in concentrated ammonia. This treatment dissolves the fibres and renders the paper impervious to water. A number of sheets

of paper are moistened on the surface, placed on each other, and thoroughly pressed. They thus are made to adhere firmly together, and are then fashioned into the various forms required. The product may replace corrugated iron for roofing, or it may be made into columns and flutings for internal decoration. It is said to be a very durable material even when exposed to air and rain.

Bowlder-like Masses of Clay in the Long Island Drift.—An extensive excavation in the side of Harbor Hill, near Brooklyn, Long Island, has revealed the presence of detached bowlder-like masses of clay embedded in the drift. Mr. Elias Lewis, of Brooklyn, who has examined these objects, writes that they lie unbroken like bowlders of granite, and have the same rounded outline. One mass, consisting of a tough, fine-grained bluish-gray clay, was eight feet in vertical diameter, and seven feet through from side to side. Mr. Lewis is of the opinion that these masses were transported by ice and deposited in a frozen state, but adds that it is difficult to understand how they should have retained their form beneath moving water during the long time necessary for the accumulation of the layers of gravel and sand which surround them; nor is it clear how stratification of deposits could occur in water deep enough to float icebergs.

Will some one familiar with glacial deposits inform the readers of THE MONTHLY whether similar masses of clay or earth of any kind are common in the recognized glacial drift?

Fuzi-Yama and Hakusan.—These, the two highest and most famous mountains of Japan, have lately had a new determination of their respective heights. A British officer made the ascent of Fuzi-Yama, on the 9th of September, and found, by approved and carefully-conducted methods, the height to be 13,080.32 feet, which is less than its accepted altitude, namely 14,177 feet. This same officer ascended Hakusan, being the first foreigner that has done so. His measurement makes this mountain higher than the accepted figures, which Stieler sets down at 8,178 feet. The new measurement gives 9,200 feet. Both these mountains are held sacred by the Japanese, Fuzi-Yama perhaps being specially so, as its singular name would imply, which means the "No-two-mountain;" that is, the none-such, the peerless, the inimitable. They are both volcanic mountains, with vast craters. Hakusan is snow-capped the whole year, while it may be called a snow-mountain for two-thirds of the year. It is sometimes called "Siro-Yama," White Mountain, and is truly the Mont Blanc of Japan. Both mountains are yearly visited by many thousand pilgrims. This last explorer describes Fuzi-Yama as an ash-heap, with a cone of lava and clinker. The only vegetation at top were lichens. "The crater, by approximate measurement, was found to be 2½ miles in circumference, and its depth about 440 feet." As the mountain is a cone, and stands by itself, it is regarded as the most beautiful mountain in the world. It would be rare to find a Japanese landscape in which the artist has not by some ingenuity introduced the peerless Fuzi-Yama.

Combustion under Pressure. — It is shown from the observations of James B. Eads, C. E., as given in the *Journal of the Franklin Institute*, that combustion goes on at the same rate in compressed as in free air. There is, however, this difference between the phenomena of combustion under the two conditions, that a flame is more readily extinguished in free than in compressed air. This is demonstrated by Mr. Eads's experiments with the flame of a candle under varying pressures. Thus, at the depth of 108½ feet in a shaft, the flame having been blown out thirteen times in rapid succession, it reappeared at the wick each time, except the last. At a somewhat greater depth, and under 52 lbs. pressure to the square inch, the flame was in the same way extinguished fifty-two times, with the same result. Mr. Eads's explanation is, that the abnormal pressure brings the oxygen of the air into close contact with the incandescent body, and so tends to keep up combustion; but the process is not more rapid than under ordinary circumstances, for the reason that the increased density of the air retards the movement of the gases resulting from combustion and surrounding the flame.

A Spider's Engineering.—A writer in *Hardwicke's Science-Gossip* saw a spider's web stretched across a small mill-stream, and attached on either side to stems of grass and other herbage. The stream was about three feet in width, and the web resembled a cart-wheel in general outline, having a diameter of at least six feet. The writer asks how "an animal that neither flies, leaps, nor swims," could accomplish such an engineering feat. But is it true that the spider does not swim or leap? In fact, the animal can run on the surface of water, can leap from place to place, and can *float* after the manner of Mr. Home the *medium*. It can even dive in water. But, further, it can swing like a pendulum, suspending itself like a thread from some elevated point. The writer in *Hardwicke* does not tell whether there was any object near the web on either margin of the stream of sufficient height to allow of the animal's so swinging from one side to the other.

Geology of the Great Plain of Morocco.—The *Journal of the Geographical Society* (British) has a paper by George Man, F. G. S., on the geology of Morocco, of which we give the substance. The plain of Morocco rises 1,700 feet above the sea-level, and is covered with a tufaceous crust, from a few inches to three feet thick, which is burnt for lime near the city of Morocco. The underlying rock is of similar composition but not so hard, and is called by Mr. Man a "cream-colored limestone and gray marl of cretaceous or tertiary age." Midway between Mogador and Morocco are flat-topped hills 200 or 300 feet high, covered with tabular masses of chalcedony. This suggests an enormous erosion of the plain. The author contradicts Rolfe and others who assert that snow remains upon Mount Atlas during the entire year, and says that in the first week of May snow was to be found only in deep gullies and in drifts. The mass of the Atlas range is mainly composed of porphyrites and porphyritic tufas, overlaid by cretaceous rocks, with basalts rising in erupted dikes and masses evidently post-cretaceous. Metamorphic rocks appear in rugged hills near Morocco, and white limestone on the high Atlas. Glacial moraines may be seen on this range nearly 8,000 feet above the sea, forming gigantic ridges and mounds of porphyritic blocks, in some places damming up the ravines; and at the foot of Atlas are enormous mounds of bowlders. These mounds oftentimes rise 2,000 feet above the level of the plain, and according to Mr. Man were produced by glaciers. Of marine drift no trace is visible.

Cross between the Zebu and European Cattle.—The organ of the Royal Prussian Agricultural Department contains a notice of some experiments on the cross between the zebu, or Indian ox (*Bos Indicus*), and European cattle, by W. Nathusius-Konigsborn. The doubts that have existed in regard to the fecundity of this cross led to the experiments which, the writer thinks, must forever set the question at rest. The male zebu made use of was a yearling calf from the Zoological Gardens, of the peculiar bluish-white color characteristic of the zebu race. Four heifers of Holland stock were got with calf by this animal, and produced two heifers and two bull-calves, all of which were successfully raised. Though the dams were variously colored, all the calves had white stars in their foreheads. When they arrived at suitable age, they were bred with each other and with other cattle, and both sexes proved in every respect capable of propagating their race. The amount of milk given by the half-bloods was about 500 quarts per annum. This was so much below the ordinary average as to prevent all hope of their being a desirable breed. In addition, the oxen, from which much was expected in speed and endurance, proved so incorrigibly obstinate as to defy all efforts to train them for the yoke, lying down on the smallest provocation, and in one case, where it was necessary to lead one of them a short distance, the animal died the next day, it was supposed from the effects of anger and excitement. They acted much more like half-tamed wild-beasts than like domestic cattle. The only redeeming feature was the quality of their flesh, which, in those that were sent to the butcher, proved to be excellent.

Solidifying Petroleum.—The *Journal de l'Eclairage au Gaz* describes as follows a

process invented by Jordery and Paschkoff for the solidification of petroleum, thus making it more easily and more safely transportable: "First make a decoction of the root or leaves of the *Saponaria officinaria*, quillay, or any other substance possessed of saponific properties. Then an amount of this decoction or extract, equal to one-twentieth of the petroleum to be solidified, is placed in a vat, and the petroleum suffered to flow in upon it slowly, the whole being constantly stirred in the mean time. This process may be followed with oils in general, and with volatile oils it will prevent loss from leakage and obviate many of the dangers now attending their transportation."

Curious Phenomenon in Vegetable Physiology.—It has long been known to botanists that, occasionally, after the felling of pine and fir trees, their stumps would continue to increase in diameter, i. e., form new woody layers for several years. Dutrochet mentions some cases of extraordinary longevity in the stock of *Pinus picea* after the trunk had been felled. He says that, in the year 1836, a stock of *Pinus picea*, felled in 1821, was still alive, and had formed 14 thin new layers of wood—that is, one each year; and another, felled in 1743, was still in full vegetation, having formed 92 thin layers of wood, or one each year. This singular phenomenon was long a puzzle to botanists and vegetable physiologists. Over thirty years ago Goeppert, an accomplished botanist of Breslau, undertook an investigation of the subject. The result is published at large in the "Annales des Sciences Naturelles" for 1843. It appears that in all the cases examined by Goeppert there was a union of the roots of the fallen trees with the roots of living trees growing in the immediate vicinity, and his explanation of the phenomenon was that the stumps maintained their growth by drawing their supplies of sap from the trees with which they were thus connected. The union of roots in these cases was sometimes woody, and sometimes only by the bark of the roots. So far as observed, this anastomosis, or natural grafting, is confined to coniferous trees, and to only a few species of them, chiefly the silver-fir, the spruce, and occasionally the Scotch fir. In the London *Gardeners' Chronicle* of August 31st is an account of an instance of this kind of anastomosis of the roots of a larch, and a figure is given of the specimen, in which the stump and its root-connections are exhibited. The cut stump shows rotten wood in the centre, with the new wood at the circumference surging over the edges of the wound.

Although the discovery of this root-union explains some of the questions involved in this curious phenomenon, it does not explain them all; for instance, why does not the sap, which is thus robbed from the roots of the nurse-tree, pass up in the usual channels and overflow at the top of the stump, as is the case when a grape-vine or deciduous tree is cut during the active ascent of the sap? As the growth of new wood in exogenous trees takes place from the cambium, and the cambium is supposed to be the sap which has been elaborated in the leaves, what is the source of the cambium in these stumps?

It would seem as if there was here a complete contradiction of the ingenious theory of some of the French botanists that wood growth begins in the leaves or leaf-buds, and descends continuously thence to the roots, so that, in fact, wood may be considered the united mass of roots which emanate from the leaves of the plant.

The theory of De Candolle is, that the woody and cortical layers originate *laterally* in the cambium furnished by preëxisting layers, and nourished by the descending sap. To use the words of De Candolle, "The whole question may be reduced to this: either there descend from the top of a tree the rudiments of fibres which are nourished and developed by the juices springing *laterally* from the body of the wood and bark, or new layers are developed by preëxisting layers which are nourished by the descending juices formed in the leaves." The latter part of this statement, though somewhat vague and unsatisfactory, probably involves the true theory of the formation of wood. The *preëxisting layers* mentioned in De Candolle's statement include the medullary rays which reach the circumference. These medullary rays are composed of cellular tissue derived from the pith, and, like it, are capable of indefinite extension by cell-multiplication.

The primary state of all the tissues of the plant is the condition of simple cells, each of which is, in a certain sense, an independent body, having its own life-work and history in the complicated mass of which the tree is composed. All extension of the tree in any direction is made through the medium of cell-growth and cell-modifications, and, wherever there is cellular tissue in a state of vitality, there may be cell-multiplication whenever material for growth, i. e., sap in different stages, is brought into contact with such tissue.

In the case of the pine-stumps alluded to, the medullary rays of the recent wood retain their vitality, and, when the sap rises, it is transmitted through these rays and through the interspaces of the woody matter to the surface beneath the bark, these being appropriated to the organization of new cells whose walls are thickened by continuous secondary deposits, as in the normal formation of woody tissue. Of course, the amount of this woody formation will be limited, from the deficient supply of sap and want of concentration which it would obtain by passing through the leaves.

Puncturing the Pericardium.—The pericardium, or membranous sac surrounding the heart, sometimes becomes so filled with liquid that the movements of that organ are impeded. This is called dropsy of the heart. The surplus fluid may be relieved by the introduction of a trocar into the sac, but the operation is regarded as extra hazardous. Dr. Chairou, of the Paris Academy of Medicine, has tried a new method of treating the disorder in question. A young soldier just recovered from a pleurisy was found presenting all the symptoms of dropsy of the heart. The physician made a puncture into the pericardium with a capillary needle, and sucked out a considerable quantity of thick sero-sanguineous liquid, which soon became coagulated. The following morning the patient was pacing the corridors of the hospital in the very best of spirits.

Slag as a Building-Material.—"What shall be done with the slag?" is always a very urgent question for the proprietors of iron-works. Many are the plans which have been proposed for the utilization of this waste material, but, if we are to judge of their value by the amount of slag utilized, it must be confessed that they do not help to answer the iron-manufacturers' question. And yet many of the processes for the conversion of slag into a material for building would seem to promise very fair results. Mr. S. Egleston lately read a paper before the American Institute of Mining Engineers, in which he gives a history of these processes, stating at the same time, in a few words, the salient peculiarities of each. After recounting the failures which attended the first efforts, the writer sets forth the process followed in Königshütte, Silesia. There the slag is run from the furnace into a hemispherical basin on wheels, the bottom being strewed with sand or fine coke-dust to the depth of an inch. It is then drawn to the place where it is moulded into bricks. The slag and sand having been mixed together till most of the gases have escaped, the whole is pressed into a mould, and punctured frequently to let out the gas. A close-fitting cover then compresses it. The red-hot brick is next taken to the kiln, covered with powdered coal, and left to anneal. Four men make 500 bricks in five hours. In Silesia these bricks cost 25 per cent. less than ordinary bricks. The lead-slag of the furnaces in the Hartz Gebirge gives bricks of inferior quality, being very brittle. A Belgian engineer, M. Sepulchre, was the first to successfully transform slag into a stone which could be generally used. He caused the slag-channels to terminate in an excavation, the sides of which had an inclination of 30°. This steep inclination causes the section of the pits to increase very rapidly, allowing the solid crust on the surface of the liquid slag to rise with it without being attached. The mass takes from five to ten days to cool. The product is a stone which, rather soft at first, grows hard on exposure to air. Slag suitable for such treatment should contain from 38 to 44 per cent. of silica. Experiment shows that stone of this kind made from the slag coming from white iron can bear a pressure of 242 kilogrammes (500 pounds) to the square centimetre (one-third of an inch) without fissure. If from gray iron, it will not crush at a pressure of 405 kilogrammes. It is, therefore, stronger than the best marble.

Antiquity of Man in America.—The discoveries that are constantly being made in this country are proving that man existed on this continent as far back in geological time as on the European Continent; and it even seems that America, really the Old World geologically, will soon prove to be the birthplace of the earliest race of man. One of the late and important discoveries is that by Mr. E. L. Berthoud, which is given in full, with a map, in the "Proceedings of the Philadelphia Academy of Sciences for 1872," p. 46. Mr. Berthoud there reports the discovery of ancient fireplaces, rude stone monuments, and implements of stone in great number and variety, in several places along Crow Creek, in Colorado, and also on several other rivers in the vicinity. These fireplaces indicate several ancient sites of an unknown race differing entirely from the mound-builders and the present Indians, while the shells and other fossils found with the remains make it quite certain that the deposit in which the ancient sites are found is as old as the Pliocene, and perhaps as the Miocene. As the fossil shells found with the relics of man are of estuary forms, and, as the sites of the ancient towns are on extended points of land and at the base of the ridges or bluffs, Mr. Berthoud thinks the evidence is strongly in favor of the locations having been near some ancient fresh-water lake, whose vestiges the present topography of the region favors.—*American Naturalist.*

Effects of Coal-Gas on Plants.—Some of our readers will remember that, in Philadelphia, a few years ago, a florist, Mr. Thomas Robertson, had his plants destroyed by gas escaping from the street-mains. He applied to the city for damages, but judge and jury decided that coal-gas would not injure plants. Since that time reports have been given of experiments by some learned Frenchman, who also decided that no injury resulted, and now it is said experiments have recently been made in Berlin to ascertain the effect of coal-gas upon the roots of trees exposed to its influence. Three trees were selected, two limes and a maple, and, after seventy days, the gas was cut off, to see whether the trees which had become blasted would recover. One of the lime-trees again put forth foliage, but exhibited evidences of ill health, while the remaining two trees were killed. That part of the earth which was compacted around the roots appeared to transmit most rapidly the poison of the gas. We suppose there is no one who has had any unbiassed experience in the matter but knows that coal-gas will destroy plants in the manner stated. Those who have had no experience had better take care to guard against it.—*Gardener's Monthly.*

Cromlechs in Algeria.—The Cromlechs (*dolmens*) of Algeria was the subject of an address made by General Faidherbe at the Brussels International Congress. He considers these structures to be simply sepulchral monuments, and, after examining five or six thousand of them, maintains that the dolmens of Africa and of Europe were all constructed by the same race during their emigration from the shores of the Baltic to the southern coast of the Mediterranean. The author does not, however, attempt to explain the existence of these monuments in other countries—Hindostan, for instance, and America. In Africa, he says, cromlechs are called tombs of the idolaters—the *idolaters* being neither Romans, nor Christians, nor Phœnicians, but some antique race. He regards the Berbers as the descendants of the primitive dolmen-builders. Certain Egyptian monuments tell of invasions of Lower Egypt 1,500 years before our era by blond tribes from the West. The bones found in the cromlechs are those of a large and dolichocephalous race. General Faidherbe gives the average stature (including the women) at 1.65 or 1.74 metre, while the average stature of French carabineers is only 1.65 metre. He did not find a single brachycephalous skull. The profiles indicated great intelligence. The Egyptian documents already referred to call the invaders Tamahu, which must have come from the invaders' own language, as it is not Egyptian. The Tuaregs of the present day may be regarded as the best representatives of the Tamahus. They are of lofty stature, have blue eyes, and cling to the custom of bearing long swords, to be wielded by both hands. In Soudan, on the banks of the Niger, dwells a negro tribe ruled by a royal family (Masas), who are of rather fair com-

plexion, and claim descent from white men. *Masas* is perhaps the same as *Mashash*, which occurs in the Egyptian documents applied to the Tamahus. The Masas wear the hair in the same fashion as the Tamahus, and General Faidherbe is inclined to think that they, too, are the descendants of the dolmen-builders.

Deep-Sea Photometer.—A deep-sea photometer, or instrument for measuring the chemical power of the solar ray at great depths in water, was shown at the late London Exhibition by Mr. C. W. Siemens. A roll of sensitive paper, hermetically closed in a glass tube, is placed in a thick disk attached to the bottom of an iron frame to be dropped by a wire into the sea. In the frame is an electro-magnet. The tube is held in a dark recess till the magnet is formed, and then it springs into the light, but is withdrawn again when the electric current ceases. The actinic force of the rays is, of course, determined from the amount of darkening produced on the paper in a given time.

Cheap Hydrogen Gas.—The statement comes from Paris that a Mr. Giffard has devised a process for the rapid production of hydrogen from water, which promises to make its use as an illuminator more economical than that of ordinary coal-gas. It is claimed that by this method hydrogen may be generated on a large scale, 18,000 cubic feet per hour, at a cost of from fifteen to thirty cents per thousand cubic feet, so that by combustion with solid refractory substances, such as magnesium, platinum, lime, marble, etc., it may advantageously compete with coal-gas for illuminating purposes.

Building-Stone and Fire.—Dr. Adolph Ott, in the *Engineering and Mining Journal*, treats of the resistance offered to fire by the various kinds of stone employed in building. According to this author, the presence of magnesia in limestone (magnesian limestone, dolomite) hastens the decomposition of the mass under the action of heat, the magnesia parting with its carbonic acid at the comparatively low temperature of 600° Fahr. Common limestone will stand a higher temperature without decomposition. As our Westchester and also Vermont marble is a magnesian limestone, this fact is of very considerable interest for this city. It appears that, in Chicago, as also probably in Boston, the sandstones made the most obstinate resistance to the heat. This is explained by the fact that the chief ingredient in stones of that class is quartz, a substance remarkable for its infusibility. As for granite, gneiss, mica-slate, and other rocks of the primary formation, which are commonly esteemed indestructible, Dr. Ott shows that they can make but very feeble resistance to heat. The water enclosed in such rocks accounts for their bursting and exploding when heated. Portland cement-stone is said to show extraordinary resistent power, almost equalling sandstone in this respect. Of brick walls the author is disposed to think well, provided they be honestly built of hard material throughout, and of the requisite degree of thickness.

NOTES.

NOTWITHSTANDING the high price of meat and the great scarcity of potatoes in England, there are this winter, says the *Saturday Review*, 40,000 less paupers in London than three years ago. This is owing to an organized system of transferring labor to portions of the country where it is most needed, and thus relieving the overstocked points where pauperism is always most rapidly developed. The *Review* calls for an extension of the system, and urges those who are wasting their funds in ill directed charities, which oftentimes actually increase the number of paupers, to give this one, which aims to make the lower classes self-sustaining, a fair amount of consideration.

MR. T. C. WEBB, of Philadelphia, has made experiments with a plate electrical machine, in an insulated room, that seem to show the fallacy of the ordinary theory of the discharge of a charged conductor. A room eight by nine feet, and about eight feet high, was constructed, and suspended upon gutta percha, and its perfect insulation shown by a Thomson galvanometer. The plate-machine acted in all respects the same as in an uninsulated room; sparks were given off, and the conductor completely discharged when touched to the sides of the building. The experiments given in the *Philadelphia Magazine* seem to show conclusively that the common theory of the electrical machine is erroneous.—*American Manufacturer.*

WRITING on the subject of malaria, Dr. Rey urges upon the inhabitants of malarious districts the adoption of every safeguard against becoming chilled. He considers the chill, often felt in warm climates at sunset, as very pernicious, and agrees with all authorities in pronouncing cold, with damp, to be exceedingly dangerous. Residents in lowland or damp situations should, therefore, take special precautions to keep the circulation in such a condition that the extremities are not cold, and the surface generally is comfortably warm. By maintaining this condition of body, other diseases besides the so-called malarial would also be warded off.

THE *American Journal of Science and Art* has a letter from a correspondent in Mississippi who states that beavers are on the increase in that State, as also in Alabama. When the writer first settled in Hinds County, Mississippi, thirty-five years ago, he could scarce find one beaver-dam in the vicinity of his residence; but, in 1850, every considerable stream in the county had its dams, which caused serious injury to the low lands. A few years ago a trapper caught over seventy beavers in less than one month's time within the limits of the county. The animals are still multiplying, and the writer has no doubt that this is true, not alone of his particular locality, but of all Central Mississippi and Alabama.

A CORRESPONDENT of the London *Times*, writing on the potato-disease, says its prevention depends upon attention to three things: 1. The choice of seed. 2. The removal of mycelium and resting spores from the seed chosen, to be accomplished by drying in the sunlight, and by dipping the seed-potatoes in a solution of lime with a little carbolic acid; and 3. The preservation of seed in a temperature which will prevent the growth of mycelium. It will not grow in a temperature below 48° Fahr.

THE immense fields of sea-wrack which are found in the neighborhood of the Gulf Stream are estimated to cover a superficial area equal to that of France. M. Leps, of the French Navy, thinks that this sea-weed could be utilized for agricultural and industrial purposes, and suggests that it might be brought home in compressed bundles, or burned on the spot, and its soda and iodine thus secured.—*American Journal of Science and Art.*

A CURIOUS cause is assigned, by M. Collas, for the blue color of the sky. In opposition to M. Lallemand, who attributes the color to a fluorescent phenomenon—a reduction of refrangibility in the actinic rays beyond the violet end of the spectrum—M. Collas maintains that the color is due to the presence of hydrated silica in a very finely-divided state, carried into the atmosphere with the aqueous vapor. The blue color of the Lake of Geneva is referred to a similar cause.—*Athenæum.*

THE Australian meat-preserving companies have commenced the exportation of bone-dust to England. By strong pressure, the crushed bones are moulded into *briquets* 6 inches square and 3 thick, weighing about 6 pounds. A ton weight of this compressed bone-dust occupies 26 cubic feet.

A VERY simple remedy for echo in large public halls, churches, and the like, is suggested by a writer in the *Railway Times*, viz., the stretching of thin wires. These break the waves of sound, and prevent reverberation.

THE London *Times* reports that Mr. Aden, in-door engineer in the Edinburgh Telegraph-Office, has invented a system by which, with existing instruments, it has been found practicable to send messages from both ends of a single wire simultaneously. The invention has been tested between Edinburgh and Glasgow, and it has been found that one wire is capable of doing double work.

THE manufacture of spirits from mosses and lichens is becoming an important branch of industry in Northern Russia. The alcohol is said to be of good quality. The development of this industry will have an important bearing on the question of food-supply in the Russian Empire; the more spirits made from Iceland moss, the more cereal grains will there be left to subsist the people.

WHEN the working-collier is provided with a safety-lamp, ingenuity must be further taxed to provide the means of guarding against his mad recklessness. The man will open the lamp, if it is at all possible, to get better light for his work, to light his pipe, or merely from foolhardiness. Lamps have, therefore, been contrived which go out on being opened. Another plan is to lock the lamp with a plug of lead, on which a device is punched, and which cannot be opened without breaking the plug. The latest contrivance is a lamp which is closed with a steel spring, and which cannot be opened except by the action of a very powerful magnet, such as the colliers would not be likely to possess.

IT is proposed in France to supersede gold and silver coinage by platinum. The use of this metal for coins is nothing new, for the Russian Empire had a platinum coinage over a quarter of a century ago. As early as 1799, experiments were made at the Paris Mint, and some beautiful specimens of platinum medals were produced.

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